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Evaluating Sustainability:
Energy and Water Conservation at UT

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Evaluating Sustainability:
Energy and Water Conservation at UT

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Thesis

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Master of Science in Energy and Earth Resources

The University of Texas at Austin

August 2015

Dedication

This thesis is dedicated to my Family, Friends, and Mentors whose guidance and patience helped me along the entire way, and in loving memory to my grandfather, Jorge Bernardo Ambriz, who would have loved to be here today.

Acknowledgements

The author would like to thank both of his thesis supervisors, Dr. David Eaton and Dr. Charles Kreitler, for their continued patience in helping build this thesis, and the many UT staff, faculty, and friends for their input. The author is extremely thankful for the time and expertise shared by every person he met.

Abstract

Evaluating Sustainability:
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The University of Texas at Austin (UT) has invested in improving sustainability on campus through its administration and operations, but it has yet to measure its performance through a comprehensive methodology. This study compares the sustainability practices at two peer universities with UT, and displays the patterns of energy and water consumption in buildings. This report illustrates energy and water conservation through indexed GIS maps.

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Acronyms and Abbreviations

The following terms are used throughout this report. The first section lists names of assessments and reports. The second section lists units and abbreviations.

AASHE	Association for the Advancement of Sustainability in Higher Education
ACUPCC	American College & University Presidents' Climate Commitment
DSEMC	Demand Side Energy Management and Conservation
E&G	Education and General space
EWC	Energy and Water Conservation
GASU	Graphical Assessment of Sustainability in Universities
LEED	Leadership in Energy and Environmental Design
PSSC	President's Sustainability Steering Committee
STARS	Sustainability Tracking, Assessment, and Rating System

BTU	British thermal unit
CHP	Combined heat and power
EUI	Energy Use Index
FTE	Full-time equivalent
GPCD	Gallons per capita per day
gal/ ft.2	Gallons per square foot
GHG	Greenhouse gas
k-BTU	Kilo-BTU
kWh	Kilowatt-hours
MMBTU	Million BTU
mgd	Million gallons per day
ft.2	Square feet
TWh	Terawatt-hours

Chapter 1: Executive Summary

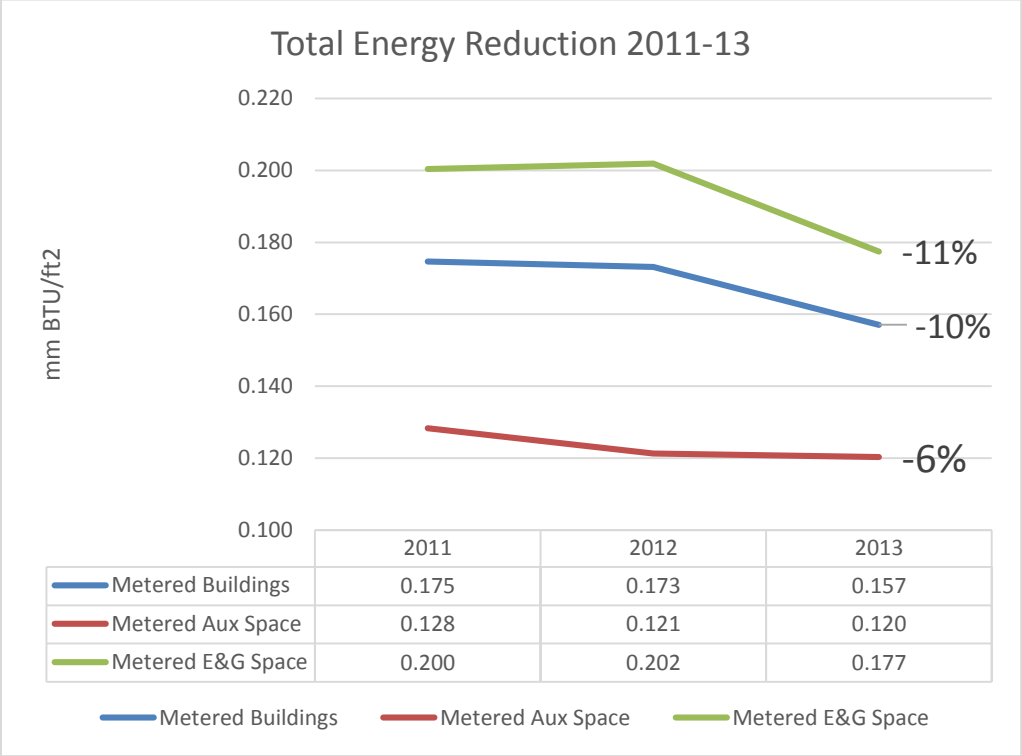
In 2011 The University of Texas at Austin (UT) announced a goal of conserving 20 percent of energy and water by 2020. To meet that goal UT has created campus programs and an Energy and Water Conservation (EWC) team that evaluates campus engagement and technical upgrade initiatives.1 This thesis analyzes UT's current conservation activities in the context of sustainability assessments at other universities to identify UT's prospects for success by 2020. One step is a comparison of UT practices with two peer universities. A second step is to use raw data from UT's Utilities and Energy Management Department to assess performance to date. The third step is to develop a Sustainability Index to depict buildings' energy and water consumption patterns as a means for UT to monitor its conservation performance.

Although UT does not monitor water and energy in every building, its EWC Report suggests that energy consumption is ahead of schedule in reaching its goal.[2] However an analysis of UT's education and general spaces as well as its campus auxiliary spaces indicates that UT buildings have not reduced energy consumption as much as estimated. Water consumption has decreased over the same time period. Comparing the conservation performance of the University of California-San Diego and Michigan State University with UT practices in all campus-metered buildings indicates that improvement is possible at UT.

Figure 1 illustrates that total energy consumption for the 99 metered buildings from 2011-13 decreased 10 percent overall. Education and General space (or 64% of metered space) decreased 11 percent, while Auxiliary space (or 36% of metered space) decreased 6 percent. Figure 2 illustrates that total domestic water use for 73 buildings metered from 2011-13 decreased 4 percent overall. Education & General space (76% of metered space) reduced consumption 9% percent. Auxiliary space (24% of metered space) increased

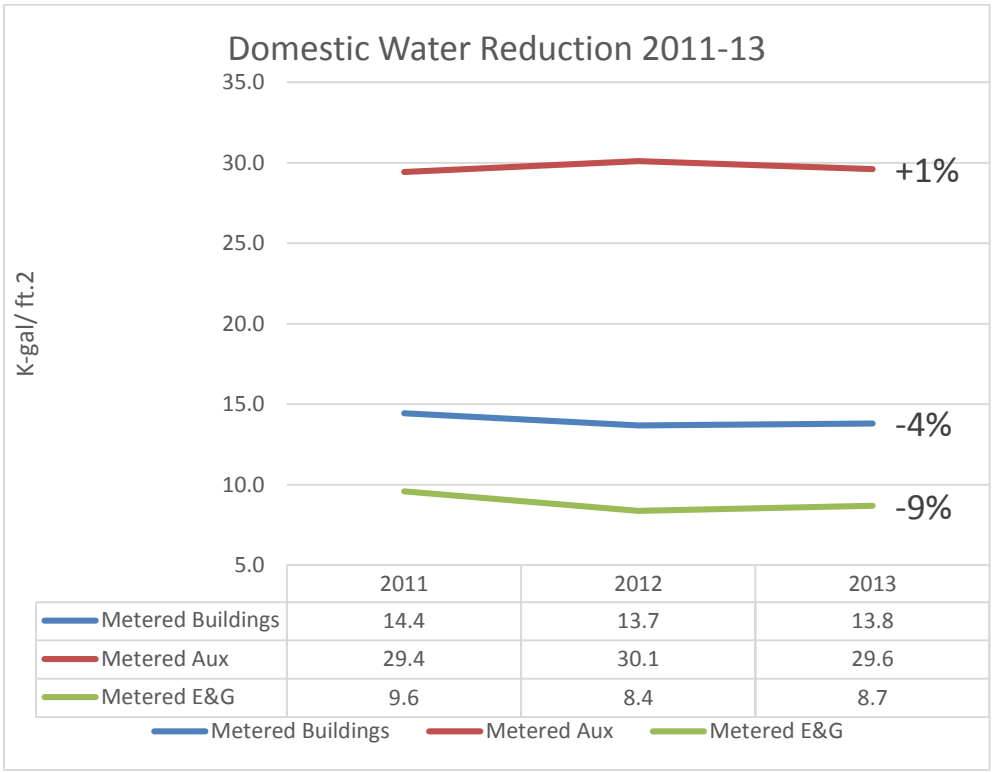
consumption by 1 percent. These data are not normalized for weather. The trends over three consecutive years of data for all metered buildings show that it is feasible for UT to conduct a campus-wide analysis of its water and energy use.

Figure 1: Total Energy Consumption for Metered Campus 2011-2013.



Source: May 8, 2015. Collected and reported in an unpublished study by Oscar Garcia, 2015.

Figure 2: Domestic Water Consumption for Metered Campus 2011-2013.



Source: May 8, 2015. Collected and reported in an unpublished study by Oscar Garcia, 2015.

Chapter 2: Introduction

The University of Texas at Austin (UT) fosters a culture of sustainability throughout its campus' academics, administration, and operations.[3] In 2007, the UT President William Powers appointed a Sustainability Steering Committee (PSSC) to expand options for actively promoting sustainability.[4] In 2008, UT adopted a Campus Sustainability Policy.[5] UT's Sustainability Directory website lists sustainability records relating to faculty, staff, centers, institutes, degrees, curricula, research, initiatives, and courses, as filtered by area of study.[6]

UT's Handbook of Operating Procedures has defined sustainability as "societal efforts that meet the needs of present users without compromising the ability of future generations to meet their own needs," and that it "presumes that the planet's resources are finite, and should be used conservatively, wisely, and equitably."7 In 2011 UT adopted sustainability goals under its Natural Resources Conservation Plan for all academic programs, administration, and operations as a basis for evaluating its actions.8 Campus utility managers announced a goal to reduce energy and water consumption each by 20 percent by the goal year 2020.9 However, as of 2015 UT has yet to evaluate comprehensively its sustainability performance against that baseline, so as to know whether UT is likely to meet its conservation goal by 2020. This study focuses on three UT sustainability initiative domains: academics, administration (policy), and operations.10

Academics

The 2009 Sustainability Directory provides one measure of academic sustainability, as it lists over one thousand partially redundant entries in an exhaustive attempt to classify faculty research, courses, and other academic engagement initiatives such as: the

Sustainability Course Development and Peer-Led Undergraduate Study (PLUS) Awards which contribute to the creation of new courses; the Faculty Learning Community; the School of Undergraduate Studies' (UGS) University Spring Lecture Series; and the Sustainability Research Network.11 The Sustainability Directory includes student and/or department led organizations that carry out events such as symposia, competitions, and conferences, frequently bridging together disciplines on sustainability issues at multiple levels of participation. The PSSC 2011-12 Annual Report listed the following active student sustainability organizations: Campus Environmental Center; Engineers for a Sustainable World; LBJ Green Society; Net Impact; and the UT Student Chapter of the US Green Building Council.12 The School of Architecture offers two sustainability degrees: the Environmental Planning for Sustainable Communities specialization - Community and Regional Planning (MSCRP) and a Sustainable Design (MSSD) program. There are approximately 40 other degrees and graduate portfolio programs that include some sustainability language such as: a CleanTech Concentration Business Administration (MBA); a Clean Energy Materials Thrust in Materials Science and Engineering (MS, PhD); and a Water Resources Emphasis in Environmental and Water Resources Engineering (MSE/PhD), to name a few. There are 33 research centers listed in the directory, such as the Center for Sustainable Design, the Environmental Science Institute, and the Center for Sustainable Water Resources.13 The directory lists 250 ongoing research initiatives, 480 courses, and 266 faculty and staff members who are associated with sustainability in UT's academic programs.14 The Sustainability Directory includes UT energy-related initiatives in conventional fossil fuels research, such as programs promoting engine efficiency and cleaner technologies of oil and gas operations, as they aim to reduce carbon footprints.15

Operations

The 140-megawatt Carl J Eckhardt Heating and Power Complex provides UT's main campus with all of its electrical power, steam, compressed air, demineralized water, and chilled water needs every day of the year.16 The combined heat and power (CHP) plant produces 345,000,000 kilowatt-hours per year serving over 160 buildings and 17 million square feet of space, 70 percent of which is consumed directly on campus and 30 percent is used to make chilled water for campus air conditioning.17 UT consumes about 800 million gallons of water per year (about 2.1 mgd), supplied by the City of Austin.18 UT is considered a leader in power plant operations efficiency, as it operates a reliable micro-grid, with current air emissions levels equal to those in 1976, despite growth.19

UT University Operations includes five departments within its Planning, Energy and Facilities (PEF) portfolio, each of which shares a sustainability role: the Office of Sustainability (OS); Campus Planning (CP); and Project Management and Construction Services (PMCS); Facilities Services (FS); and Utilities and Energy Management (UEM).20 FS and UEM are grouped as Utilities, Energy & Facilities Management, while OS, CP, and PMCS are grouped as Campus Planning & Project Management.21 Other University Operations departments also promote sustainability in practice, including: Housing and Food Services, Document Solutions, Environmental Health and Safety, Intercollegiate Athletics, Parking and Transportation Services, Recreational Sports, University Unions, and the UT Staff Council.22

Facilities Services has the largest influence on UT's sustainability as it oversees 19 million square feet of space including satellite research centers outside of the main campus. FS adopted an Energy and Water Conservation (EWC) program in 2012 that seeks to reduce energy and water use by 20 percent through campus behavioral changes and technical upgrades.23 Some examples of FS initiatives include: Conservation Conversation

presentations; holiday scheduling energy demand management; the Horns Up Sash Down initiative (partnered with Green Labs) on energy efficient laboratory fume hood practice; the Longhorn Lights Out initiative of powering down devices on specific dates; individual space Power Down Assessments; the Ultra-Low Freezer Loan Program (partnered with Green Labs) to create alternatives to using wasteful freezers in the lab and other energy conservation measures.24

Utilities and Energy Management provides the main campus with electricity, steam, chilled water, deionized water, compressed air, emergency power, and elevators services.25 UEM's Carl J. Eckhardt Heating and Power Plant increased its overall efficiency from 48 percent to 86 percent from 1976 to 2013 through energy efficiency upgrades, retrofitting infrastructure, organizational and personnel realignments, studies of energy systems, and increasing production capabilities, while reducing fuel consumption and emissions.26 Climate action planning began with the Greenhouse Gas Inventory.27 The energy management system uses two dashboards. The Indusoft Dashboard derives information from 2-second real-time data and can be used for building performance analysis. The Enurgy Dashboard draws from this raw data and corrects for cost and engineering analyses.28

The Office of Sustainability (OS) was created in 2009 and promotes sustainability through student engagement opportunities including internships, jobs, and volunteer positions.29 The OS website guides users to the Bike Shop, Concho Community Garden, and Tailgate Recycling programs which are currently promoted, and campus events coordinated in collaboration with other departments.30 Campus Planning (CP) facilitates planning of major projects and communicates this to the campus community.31 CP liaises with the Board of Regents and UT System staff during building design and construction, although the website does not list or link to any direct sustainability activities.32

Project Management and Construction Services is UT's transformative unit for managing all construction and renovation projects under $4 million, serving over 14.5 million square feet.33 PMCS has a facility management policy to promote environmental stewardship in how materials and equipment are selected. For example, UT has built and is constructing buildings that meet Leadership in Energy and Environmental Design (LEED) standards, now over 2 million gross square feet in 13 buildings.34

Policy

UT's President Powers took several administrative initiatives, beginning with creating the Task Force on Sustainability (2007) which became the PSSC's Academic and Operations sub-committees.35 President Powers announced a Campus Sustainability Policy in 2008 asking UT to adopt policies, practices, and curricula guided by principles of sustainability, and the Office of Sustainability to promote sustainability.36 In 2009, UT committed to the Clinton Global Initiative that all future construction would be designed at minimum for a Silver LEED rating by the US Green Building Council.37 That year the Good Company prepared a greenhouse gas emissions inventory following The Climate Registry's inventory methods.38 However, UT is not a signatory or member of the American College and University Presidents' Climate Commitment or The Climate Registry, respectively.39 In 2011, UT students voluntarily imposed a Green Fee, a supplemental course fee of $5.00 per long semester and $2.50 per summer session to fund projects and research in "environmental services."40 In academic year 2010-11, the PSSC adopted the AASHE's STARS survey as a metric for campus sustainability.41

In academic year 2011-12, the PSSC played a role in the Campus Master Plan by supporting creation of a revolving energy fund and an incentive fund to support development on teaching of curricula with an emphasis of sustainability and ethics.42 In

December 2012, the EWC program was officially realigned to address UT's conservation goals.43 Other accomplishments include expansion of the Sustainability Directory and adoption of the Green Purchasing Policy.44 The Natural Resources Conservation Plan created benchmarks and goals for resource conservation on campus.45 In 2012 the Mitchell Foundation made a gift of $250,000 each year for three years to inspire the UT campus' academic and operations' sustainability.46 In 2012, the Green Labs Initiative completed a pilot program report.47 The Campus Master Plan integrates sustainability in its tasks and vision, ensuring that sustainability is in the planning of UT's growth.48 Table 1 lists the sustainability related goals of the Campus Master Plan. Although there is no PSSC report for academic year 2012-13, it was the time period of the first EWC Executive Annual Report on conservation progress.

Assessments

The Demand-Side Energy Management & Conservation Program conducted by Jacobs Co. and UT was launched in 2007 to audit 122 buildings and retrofit in them lighting, steam, and water fixtures to reduce energy and water use.49 The results of this five year effort include a 2.8 percent reduction in campus energy demand, as monitored using Federal Energy Management Program (FEMP) guidelines, and 28 percent savings in irrigation, among other benefits. Although total water consumption declined initially, by 2014 water use has risen back to levels of the project's inaugural year.50

UT completed its first STARS assessment in 2011 to monitor progress. UT reapplied after the initial rating expired in 2014, earning a Silver rating.51 The 2012-13 EWC Executive Annual Report, an internal assessment, summarizes on an aggregate level the consumption of energy and water in metered Educational and General (E&G) spaces that underwent EWC initiatives.52 This does not include buildings in the following

Auxiliary space categories: dorms, food service, multi-use, office, parking, and public assembly. The most recent 2014 Energy Conservation Scorecard (see Figure 3) shows the Energy Use Index (EUI) dropped 16.5 percent, projecting that UT would meet its conservation goals ahead of schedule.53 This Scorecard includes additional E&G spaces that were not affected by the EWC initiatives.54 The EWC conducted a Building Energy Audit in five buildings during April 2013 in an effort to monitor their initiatives' progress and observed EUI decreases attributed to behavioral programs; however, no specific measures for building performance were used or monitored. 55

UEM conducted its own separate analysis on energy conservation comparing FY 2014 with a baseline year of FY 2012, using different assumptions (see Figure 4). This case includes energy data from all E&G and Auxiliary space served by the power plant, normalized monthly for weather, excluding parking garage spaces for their minimal consumption. From the initial 71 buildings, 36 remained after removal of outliers and incomplete data. Before accounting for weather and campus growth, energy to campus showed a 5 percent reduction.56 It also found that 18 buildings not implementing energy conservation measures during the observed time period used on average 9 percent more energy for chilled water, 23 percent more for steam, and 2 percent less for electricity.57

According to the US Department of Energy (USDOE), nearly two fifths of primary energy consumed and 72 percent of all electricity consumed in the US is attributed to buildings.58 The commercial and institutional sector takes up 17 percent of all public water withdrawals, which includes facilities found in a typical university.59 Thus, the urbanized setting of a university campus holds great potential for developing effective sustainability metrics and goals for the built environment.

Proposal

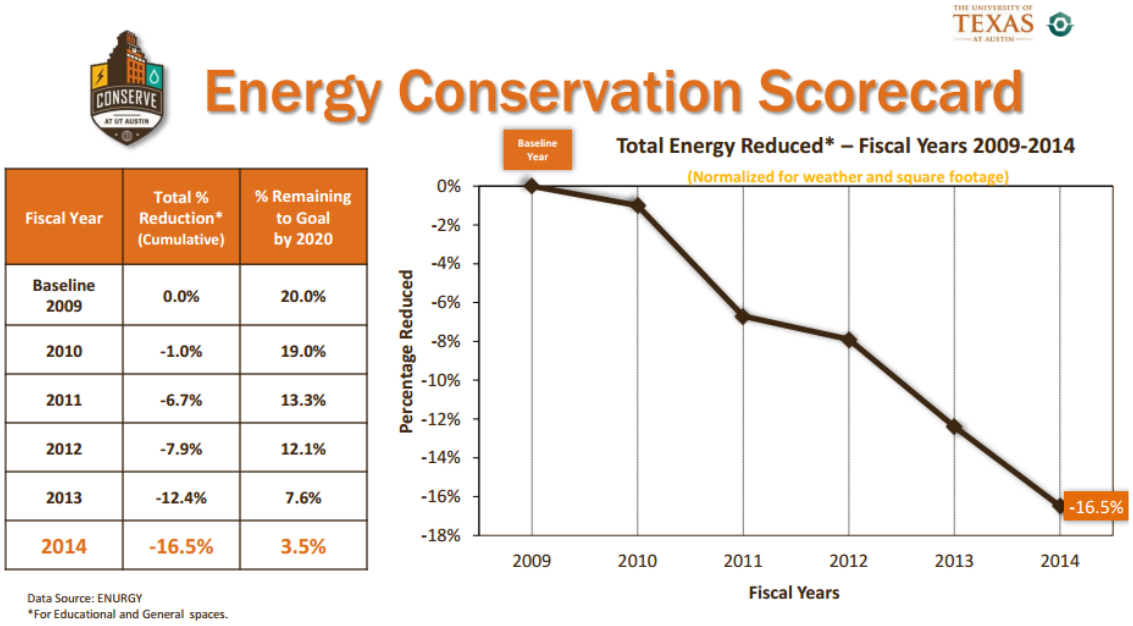
Monitoring campus energy and water conservation at the building level could produce useful guidance to enhance use reductions. This report examines sustainability assessments and efforts of peer universities to evaluate energy and water consumption of UT's main campus buildings. The analysis will summarize the current status of conservation at UT and evaluate building consumption over the last five years by space type. It will compare practices versus peer universities and prepare a "UT Building Sustainability Index" to assess energy and water conservation. The results can provide an impetus for future research and promote stronger interdepartmental collaboration in building energy and water conservation to achieve UT's sustainability goals.

Table 1: 2012 Campus Master Plan Sustainability Goals

2012 Campus Master Plan Sustainability Goals	
Sustainability Theme	**Goal**
Energy	1. The University of Texas at Austin will reduce energy consumption at the building level by an average of 20% per square foot per degree-day by August 31, 2020 using 2009 as the base year. 2. 5% of all energy consumed by UT Austin facilities on the Main Campus, approximately 17M kWh, will be generated from renewable sources by August 31, 2020.
Landscape	UT Austin will reduce water use by 20% with at least 40% of total water use coming from reuse/reclaimed sources by August 31, 2020.
Mobility	1. UT Austin will reduce use of gasoline and diesel fuels for the campus vehicle fleet by 20%, while shifting 50% of the campus vehicle fleet to E85 gasoline and other alternative fuels by 20% by August 31, 2020. 2. UT Austin will increase the number of car pool and mass transit users by 30%, and will utilize 100% natural gas fuel for the shuttle bus system by August 31, 2020.
Community	No specific goal.
Economic Development	No specific goal.
Mission	No specific goal.
Ecology	No specific goal.

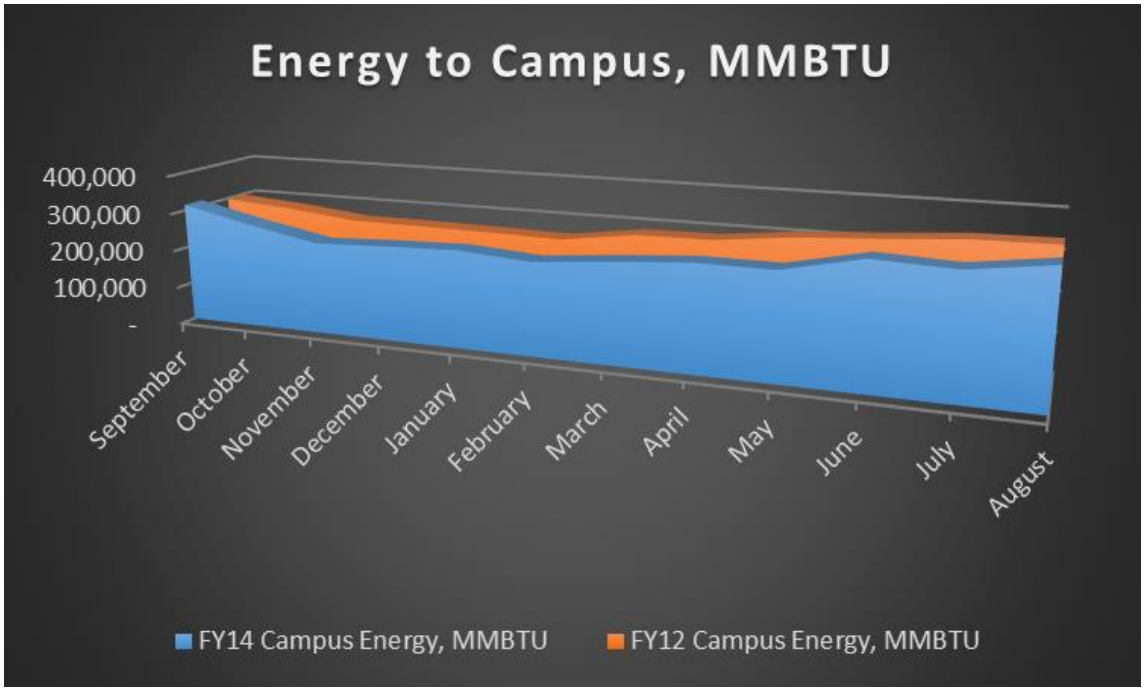
Source: VP for University Operations. "2012 Campus Master Plan." Campus Master Plan. The University of Texas at Austin, 1 Jan. 2012. Web. 30 Oct. 2014. <https://www.utexas.edu/operations/masterplan/>.

Figure 3: EWC Energy Conservation Scorecard.



Source: "Energy & Water Conservation Program (EWC)." Energy & Water Conservation. Office of the Vice President for University Operations, 1 Feb. 2015. Web. 1 May 2015. <https://www.utexas.edu/facilities/EWC/>.

Figure 4: UEM Energy Avoidance 2014.



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Chapter 3: Literature Review of Campus Sustainability Practices

Sustainability assessments in higher education often target individual issues, such as composting, recycling, or conservation, without evaluations from the entire university system as a whole.[1] This review reports on energy and water conservation in two sections: sustainability assessments and campus sustainability. The first section addresses how university policies have embraced sustainability and explores campus sustainability assessments found through online searches. Higher education sustainability assessment studies and ten assessments of different characteristics are reviewed for their approaches and findings. Table 2 lists each assessment and its source. The second section looks at university campus sustainability, with particular attention to conservation of energy and water, as assessed through resource conservation and building performance on campus. Table 3 lists the section's cited literature.

Sustainability Assessments

US universities have begun to adopt sustainability in word and deed to enhance their image, save money, attract students and resources, and promote knowledge transfer. In a 2011 study (White), 27 universities articulated sustainability policy, as found in the Association for the Advancement of Sustainability in Higher Education (AASHE) "campus sustainability and environmental plans" inventory.[2] As of 2015 there are 47 plans listed in the AASHE inventory alone, although the policies and plans take several forms reflecting institutions' size, resources, previous agendas, etc. Some US universities have begun to adopt Climate Action Plans, Sustainability Plans, Strategic Plans, and other operational campus policies, to interpret sustainability into daily and future college campus activities.[3]

The sustainability plans adopted by college and university campuses were from sixteen states plus the District of Columbia, each varying in categorical emphasis and scope.

There is no standard for sustainability planning; plans commonly focus on operations and academics as domains of implementation strategy.4 There are common themes among the study's 27 US university sustainability plans found. About 96 percent of campus plans addressed energy use; 89 percent addressed the built environment; 85 percent included a water section; and 67 percent had a section on landscaping and grounds.5

Apart from university self-assessments, ten organizations have established criteria for evaluating campus sustainability (including nonprofits, government agencies, and higher education institutions). Their ten assessments are: Sustainability Tracking, Assessment & Rating System (STARS); Guide to 332 Green Colleges; College Sustainability Report Card; GreenMetric; Cool Schools Report; Assessment Instrument for Sustainability in Higher Education (AISHE); Alternative University Appraisal; Learning in Future Environments (LiFE); the Green Plan; Unit-Based Sustainability Assessment Tool (USAT). Table 4 shows UT's performance under five of these assessment metrics.

Of the ten assessment methods found (see Table 2), half were designed to be external assessments of an institution and the other half used by an institutions for self-guidance. Five metrics' methods contained sufficient quantitative content to examine the weight of each sustainability category in its point system, and two were measured as percentages of total sustainability indicators. Three metrics (AISHE, AUA, and LiFE) provide a framework for a university to self-evaluate, but offered no quantitative scoring methodology; these are administered as surveys.

The Sustainability Tracking, Assessment, & Rating System (STARS) is a self-reporting framework for colleges and universities to measure sustainability performance.6

Over 650 colleges from 17 countries have participated. Universities aim to reach a Bronze, Silver, Gold, or Platinum STARS rating determined by a point system that accounts for performance in five categories: academics, engagement, operations, planning and administration, and innovation. The points (maximum of 208) are awarded by weighted subcategories with total possible points divided into: curriculum (19 percent), public engagement (11 percent), campus engagement (10 percent), research (9 percent), and air/climate (5 percent).7

The Guide to 332 Green Colleges lists universities that pursue sustainability through academic offerings, campus infrastructure, activities, and career preparation.8 In 2014 there were 330 universities in the US and 2 from Canada that were accepted because they scored a minimum of 83 out of 99 points in a ten-question survey.9 The guide is not intended to rank schools but to indicate these schools' commitment to sustainable practices.10 The questions are equally weighted and cover topics for improving sustainability on campus, graded on response quality.11

A College Sustainability Report Card (administered from 2007-11) graded universities' sustainability efforts on a 4.0 scale. The last report assessed 322 schools from the US and Canada.12 Each college received a letter grade based on 52 indicators within 9 categories of questions tallied up a letter grade, yielding 950 possible points, including extra credit points offered in various categories that stood out as individual indicators.13 The top three indicators, each worth 4.21 percent of a perfect score, were related to the university's investments as a shareholder engagement, investment priorities, and endowment transparency. The College Sustainability Report Card's emphasis on university investments is a different perspective on sustainable practices, as it does not directly relate to daily campus activities.

A GreenMetric beginning in 2010 has ranked universities across the globe in sustainability. The latest release from 2013 ranks 301 universities from 61 countries, and asks six categories of questions.14 The top weighted category of energy and climate change accounts for 21 percent of the highest score with each of its seven indicators being worth 3 percent. The highest weighted individual indicators were two in water (10 percent) category equally holding 5 percent (water conservation program and water piped). Following these were 12 indicators equally worth 3 percent from both the waste and energy-climate change categories. The GreenMetric addresses land use (which is not addressed in some other assessments) and awards points for the percentage of ground cover that is vegetation, forest, and permeable enough for water absorption.

The Cool Schools Report ranks the 173 universities that responded to the 68-question survey covering 11 green categories.15 Rankings were determined by a point system with the highest weighted categories in energy (25 percent), transit (12 percent), waste (11 percent), and water (10 percent). 16

The Green Plan helps universities "self-diagnose" sustainability activities based on a scorecard.17 The framework allows universities to assess and compare themselves to other institutes based on five focus areas with over 200 total qualitative and quantitative performance indicators.18 Social policy and regional presence (29 percent), environmental management (21 percent), and teaching and training (19 percent) categories contributed the largest share of points.

A Unit-Based Sustainability Assessment Tool (USAT) approach borrows from multiple assessments to tailor a holistic sustainability evaluation.19 The USAT rates a university on a scale from 0-4 based on information adequacy.20 USAT includes 4 categories, within which lie 21 subcategories and 75 indicators. The subcategories with the largest concentration of indicators were student activities (14.7 percent), sustainability

administration (13.3 percent), and supporting sustainability (13.3 percent). The USAT considers two unusual metrics, staff expertise and staff willingness to be helpful.

The Alternative University Appraisal (AUA) is a qualitative self-assessment guide that includes 22 questions in five categories designed to apply to any aspect of sustainability practices.21 The AUA asks five questions on governance, nine on education, four on research, and four on outreach. Rankings reflect a university's level of commitment to sustainability, promotion of research and activities pertaining to sustainable development and its best practices.22

The Assessment Instrument for Sustainability in Higher Education (AISHE) workshop includes 30 qualitative indicators. 23 AISHE both guides users through a process of planning, attaining their goals, and evaluating quality management to ensure progress.24 The tool consists of five sections: vision and policy; expertise; educational goals and methodology; education contents; and results assessment. An analyst can compile an AISHE in a day, given a set number of participants, timed sections for planning and discourse, and evaluation.25

Learning in Future Environments (LiFE) is another tool to self-evaluate strengths and weaknesses available exclusively for supporting universities who are members of the Environmental Association for Universities and Colleges (EAUC). It includes four priority areas with 14 frameworks, consisting of 8 activity areas each.26

The US Environmental Protection Agency (USEPA) Sustainability Analytics evaluates sustainability based on social, economic, and environmental equity factors through a set of assessment procedures that focus on a project's needs, scope, and purpose.27 The USEPA report provides examples of measuring sustainability.28

Measuring a university campus calls for its own set of economic, social, and environmental impact indicators.

According to Shriberg, the ideal assessment tool must exhibit the following five criteria: identify important issues, be calculable and comparable, move beyond eco-efficiency, measure process and motivation, and stress comprehensibility.29 In 2002 Shriberg studied sustainability for higher education by reviewing 11 assessment tools.30 He notes how universities and colleges have produced commendable results using local sustainability assessments that may not be cross-cutting, may lack empirical data, and may be of limited value to other colleges. He also reports that colleges use baseline data and initiatives, but may lack measures for comparing institutions to each other. The only common result is that institutions commit to reduce their consumption of resources.31 Shriberg cautioned that sustainability assessments with rankings and standards could discourage universities from participating because they may include subjective goals.32 For institutions that seek to lead sustainable practices, competition in standardizing and assessments may be beneficial.

In 2006, Lozano studied the reporting and assessing of sustainability and found that of the three methods to assess sustainability – accounts, narrative assessments, and indicators – the indicator-based assessments are the most useful, transparent, and consistent.33 Lozano created his own modified assessment based on earlier work by Cole, the Graphical Assessment of Sustainability in Universities (GASU).34 Lozano's tool is more inclusive of the research and education components of sustainability in higher education than in the Global Reporting Initiative (GRI).35

In 2011 Lozano utilized GASU to study 12 universities' reporting of sustainability based on 126 indicators: 10 core and 3 additional economic indicators, 16 core and 19 additional environmental indicators, 24 core and 24 additional social indicators, and 10

core and 20 additional educational indicators.36 He found that sustainability reporting in universities is still nascent, but could improve to reach the volume and depth seen in the corporate world.37 He used the structure of the GASU to report on the strengths and weaknesses in each university's indicators and their relative scoring, a methodology that could be applied to other institutions.

As of 2015, 695 American college and university presidents have made a climate commitment as a public goal (ACUPCC signatories). These ACUPCC signatories have collectively produced 2,151 greenhouse gas inventories, 533 climate action plans, and 364 progress reports.38 Over 300 private and public institutions have committed to The Climate Registry, to reporting and mitigating carbon emissions through training guidelines and a partner network.39 Universities Pricing Carbon is a Stanford-based movement creating a carbon-pricing mechanism for universities to control greenhouse gas discharges. This initiative arose from the Program on Energy and Sustainable Development at Stanford as a way to promote climate mitigation within academia and without inviting divestment from fossil fuels.40

Although many higher education institutions track sustainability, their empirical data and metrics for evaluation may be less evident than their positive intent. The ACUPCC only requires tracking progress of goals; it does not specify performance measures, just the aim to reduce greenhouse gas emissions.41 The field is filled with third-party assessment tools, self-evaluation by schools, and case studies; many reputable institutions do not participate at all. Shriberg suggested that hesitation to create a universal set of standards for measuring sustainability exists because of the strong possibility that it would discourage participation.42 He uses risk of embarrassment as a reason why many assessments are in the form of surveys or simple qualitative metrics, repeated in a survey so that universities

cannot be ranked. For the purpose of promoting transparency in sustainability efforts, the next section looks at how institutions have measured conservation.

Campus Sustainability

The reduction of resource use on campus is the one consensus Shriberg's metric found within sustainability assessments. The goal is "decreased throughput," which includes energy, water, and other material resources. Sustainable practices are those that aim to stabilize resource use with their respective ecosystem's carrying capacity.43 Table 3 lists the evaluations in campus sustainability.

Resource conservation relates to three of Graedel's five sustainability pillars for a university: energy use, water use, the use of other non-renewable resources, emissions to the environment, and land use.44 All five are at least indirectly related, as emissions are products of campus operations inputs like fuels. Land use has conservation potential through irrigated fields and limiting urban sprawl. Graedel outlines what a university campus could achieve to be considered 'sustainable' over a 50 years plan: independence from non-renewable resources with no externalities to the air, land, and water. Because a campus is a micro-community, growth is expected and often encouraged. The argument against assessing performance normalized for population or size growth is that growth, if made sustainably, should not have to be penalized.45

Amaral et al. found the two types of sustainability assessments and reporting are university-specific assessments and university-oriented assessments.46 The study corroborates the importance of tracking progress consistently, suggesting an institution can align its management system with its reporting method if it seeks to improve on benchmarks.47 For instance, The University of Saskatchewan evaluated four assessment tools, choosing from two university-based and two general sustainability tools.48 To

determine the best assessment, the university used 27 questions rated from 0 to 4 based on their ability to provide information.49

Amaral concluded that sustainability practices at a university can be categorized as either "Green Building" or "management" initiatives, commonly chosen because of the opportunities for economic savings from reduced energy consumption.50 Leadership in Energy and Environmental Design (LEED) certification by the US Green Building Council (USGBC) is a popular method for controlling energy consumption in the built environment, allowing for four levels of certification from "Certified" to "Platinum," amongst five possible building classifications.51 A university building can apply for LEED certification in the Building Design and Construction - Schools classification, for example, and be assessed based on the following indicators: 8 Location & Transportation, 9 Sustainable Sites, 7 Water Efficiency, 11 Energy & Atmosphere, 7 Materials & Resources, 12 Indoor Environmental Quality, 2 Innovation, and 1 Regional Priority.52

Buildings consume energy and water, and self-monitoring can provide insight for resource management. Energy Star's most recent Portfolio Manager Data Trends reports for energy and water use can capture voluntarily submitted information of buildings in the US. Energy use was compiled from all 50 states, totaling to 35,000 buildings from years 2008-11; the study identified that they saved an average annual 2.4 percent of weather-normalized energy use intensity.53 Analyzed by building type, savings ranges from 2.5 percent total savings (hospitals) to 11 percent total savings (retail). Approximately 70 percent of the buildings reduced energy consumption. Approximately 90 percent of these buildings reduced energy use by 0-10 percent.54 Median water use intensity (gal/ ft.2) is tracked for 6.2 billion square feet through mid-2012 of diverse construction, ranging from 4 (warehouse) to 60 (senior care facility).55 Consumption categories are Indoor Only,

Outdoor Only, Indoor & Outdoor, and Other Combinations, but specific conservation measures were not recorded.

A number of universities report that monitoring building consumption can lead to reductions.56 A typical university's electricity profile consists of lighting, ventilation, and cooling; natural gas may be used for space heating.57 Over 300 million ft.2 of dormitories tracked their energy use intensity, ranging from 40-600 k-BTU/ ft.2 Median water use intensity was reported as 36 gal/ square foot.58

Residence halls can be primary targets for universities intending to reduce consumption because occupants live there (unlike in office spaces) and conservation also promotes campus engagement. Some simple interventions include shutting off electronics and water fountain cooling systems, or changing temperatures slightly for climate control and appliances without reducing comfort levels. Efficiency upgrades with a high upfront costs can eventually pay themselves off in earned savings.59 Water conservation follows similar approaches. For example, reduced flow fixtures save water consumption, smarter leak management, and controlled consumption thresholds compensate for the behavioral aspects of usage that are difficult to implement.

In 2010 the University of Michigan (UM) studied its campus population's behaviors towards a building energy conservation program, Planet Blue.60 It found that UM staff are most concerned about conservation while students are least concerned. University efforts had mostly gone unnoticed and those who knew about them felt they were inadequate; electricity was being consumed by electronics wastefully; and building occupants are willing to sacrifice some climate control comfort for conservation.61 By focusing on the state of conservation at their campus, UM identified weaknesses to address in their built environment before expanding their program.

In 2011 Duke University reported that water resource management in higher education was less of a sustainability planning priority than energy, waste, and climate change management.62 Duke surveyed sustainability and facilities managers and found campus water resources are adequately managed, they are not prepared to address future problems, and there is a potential for additional energy and water conservation.63

In 2014 Bartos reported Arizona's co-benefits directly related to savings in energy and water.64 Water conservation policies could save the state up to 3.1 percent of electricity demand. Implementing strategies for energy efficiency/conservation measures and renewable energy portfolios can save up to 15 percent of the state's nonagricultural water demand.65 In Texas, 595,000 million-liters of water annually are used for cooling thermoelectric power plants which produce 400 terawatt-hours (TWh) of electricity; and the state uses 2.1 to 2.7 TWh of electricity for water systems and 1.8 to 2.0 TWh for wastewater systems.66 A UT study reported that the US water system used 12.6 percent of national primary energy in 2010, and recommended that addressing water heating is the most effective way to conserve energy.67 This energy-water nexus is germane for UT, as the university campus produces most of its own power and operates its water use as a "micro-grid."

University campuses vary in area, land uses, number of buildings, geography, climate, and so forth. Therefore, conservation planning requires an understanding of the campus and each of its buildings. For example, analyzing costs and benefits for upgrading dormitories' fixtures using water would depend on the room counts and residents; each facility or residence hall have its own energy and water use profile.

Both water and energy consumption patterns depend on the behaviors of occupants. The US Geological Survey states that water consumption estimates per capita per day (GPCD) range from 80-100 gallons for a typical person's household use.68 Austin Water's

immediate conservation goal is to decrease average per capita demand to 140 GPCD by 2020.69 The University of California's Sustainable Water Systems Policy asks each campus to reduce its per capita potable water consumption by 20% by the year 2020.70 Electricity power consumption is measured by the World Bank as kilowatt-hours (kWh) per capita.71 California's Energy Commission reports consumption statistics for each state by per capita electricity use the same way.72 University student consumption estimates do not exist but may be useful for conservation planning.

A campus community of diverse end-uses and sources of energy and water can exhibit opportunities and drawbacks. Aggregate-level consumption measures used by universities can miss lower-level trends. This report uses peer universities' practices and UT building consumption to evaluate performance.

Table 2: Campus Sustainability Assessments.

Sustainability Assessments			
Assessment	Organization	Year Adopted	Source
Sustainability Tracking, Assessment & Rating System	Association for the Advancement of Sustainability in Higher Education	2010	https://stars.aashe.org/pages/about/stars-overview.html
Guide to 332 Green Colleges	Princeton Review	2008	http://centerforgreenschools.org/PrinRevGdGreenCols_2014Edn.pdf
College Sustainability Report Card	Sustainable Endowments Institute	2007	http://www.greenreportcard.org/media.html
GreenMetric	Universitas Indonesia	2010	http://greenmetric.ui.ac.id/page/
Cool Schools Report	Sierra Magazine	2007	http://www.triplepundit.com/2012/08/sierra-magazine-cool-schools-ranking/
Assessment Instrument for Sustainability in Higher Education	Dutch Foundation for Sustainable Higher Education	2001	http://www.eauc.org.uk/theplatform/aishe
Alternative University Appraisal	Hokkaido University	2009	http://www.eauc.org.uk/theplatform/alternative_university_appraisal
Learning in Future Environments	Environmental Association for Universities and Colleges	2014	http://www.eauc.org.uk/life/why_life
Green Plan	Conférence des Grandes Ecoles	2010	http://www.developpement-durable.gouv.fr/Green-Plan.html
Unit-Based Sustainability Assessment Tool	Swedish/Africa International Training Programme	2009	http://www.pnuma.org/educamb/Red%20de%20Formacion%20Ambiental/Contenido%20GUPES/Docs%20GUPES%20-PNUMA%202012/7%20MESA%20Audit%20tool%20FINAL%202012%20(Africa).pdf

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Table 2 Continued

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Table 3: Campus Sustainability Literature.

Campus Sustainability Literature		
Author	Content	Index
Shriberg, Michael (2002)	11 sustainability assessments are critically analyzed; common themes of agreement are found, producing best practices for assessment	43
Graedel, T.E. (2002)	Identifies five areas for a university to address sustainability in a long-term, quantifiable outline	44
Amaral, Luis P. et al. (2015)	Outlines two university-specific sustainability tools and provides updated view of the efforts for sustainable development in universities	46
Sayed, Abu and Margret Asmuss (2013	University of Saskatchewan determines the best sustainability assessment to meet their goals by rating 5 available tools	48
Marans, Robert W. and Jack Y. Edelstein (2010)	Uses a multi-method approach to assess the Univeristy of Michgan's conservation behavioral status	60
McHugh, Amani N. (2011)	Finds that water management is less of a priority than energy and climate change; universities must implement Integrated Water Resource Management	62
Bartos, Matthew D. and Chester (2014)	Evaluates co-benefits for the State of Arizona's energy and water nexus that could be applied to other scales	64
Stillwell, Ashlynn S. et al. (2011)	Quantifies the Texas energy-water nexus in terms of power production and water resources	66
Sanders, Kelly T. (2013)	Quantifies the US energy-water nexus and identifies strategies for co-benefits of conservation	67

Sources: Shriberg, Michael. "Institutional Assessment Tools for Sustainability in Higher Education: Strengths, Weaknesses, and Implications for Practice and Theory." International Journal of Sustainability in Higher Education 3.3 (2002): 254-70. Emerald Insight. MCB UP Ltd. Web. 12 Mar. 2015. < http://www.emeraldinsight.com/doi/full/10.1108/14676370210434714 >.

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McHugh, Amani N. "An Assessment of Sustainable Water Management at University Campuses." (2011). UMI Dissertations Publishing. Web. 1 Apr. 2015. < http://search.proquest.com/docview/917477000/previewPDF/769E9CEEF9424A4CPQ/1?accountid=7118 >.

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Stillwell, Ashlynn S., Carey W. King, Michael E. Webber, Ian J. Duncan, and Amy Hardberger. "The Energy-Water Nexus in Texas." Ecology and Society 10.1 (2011). Resilience Alliance. Web. 12 Mar. 2015. < http://www.ecologyandsociety.org/vol16/iss1/art2/ >.

Sanders, Kelly T. "Analytical Methods and Strategies for Using the Energy-water Nexus to Achieve Cross-cutting Efficiency Gains." (2013). Web. 1 Nov. 2014. < http://repositories.lib.utexas.edu/handle/2152/23194?show=full >.

Table 4: UT Sustainability Assessment Rankings

UT Sustainability Assessment Rankings				
Organization	Assessment	Rank/Rating	Score	Year
AASHE	Sustainability Tracking, Assessment, & Rating System	Silver	55.88/100	2014
Princeton Review	Guide to 332 Green Colleges	n/a	>= 83/99	2014
SEI	College Sustainability Report Card	B+	>= 50/100	2011
UI	GreenMetric	14/52	6,548/10,000	2014
Sierra Magazine	Cool Schools Report	77/173	610/1,000	2014

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[8] Princeton Review. "The Princeton Review's Guide to 332 Green Colleges." TPR Education IP Holdings, 1 Jan. 2014. Web. 12 Nov. 2014. < http://www.centerforgreenschools.org/greenguide >.

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Chapter 4: Methodology

This report compares energy and water conservation at The University of Texas at Austin (UT) with peer universities as well as UT campus sustainability initiatives. Table 2 lists the methods for evaluating sustainability in colleges and universities.

Peer universities are those chosen from a list of 14 universities that UT publications use called the National Comparison Group (see Table 5). This group is used for comparing official statistics, excluding faculty salaries.1 The peer universities meet three criteria:

- the campus supplies the majority of its power through a "micro-grid;"
- there is a cogeneration or combined heat and power (CHP) plant; and
- the campus comprises the main power demand.

These three attributes fit UT's energy supply circumstances. The most appropriate campuses for comparison are The University of California-San Diego (UCSD) and Michigan State University (MSU). MSU and UCSD online publications provided information on university practices, including campus engagement, building efficiency, Leadership in Energy and Environmental Design (LEED) certifications, energy dashboards, and overall campus performance. Table 6 lists these publications. Table 7 is the Peer University Comparison.

The primary source of data for UT's analysis is the annual raw data gathered from the Utilities and Energy Management (UEM) Indusoft Dashboard for the period of January 1, 2011 to January 1, 2014. The UEM Indusoft Dashboard reports the following variables for building data: total energy, cooling, electric power, heating, and domestic water. This analysis used total energy and domestic water to analyze conservation. Buildings analyzed were those consecutively metered for the three years, which includes 99 buildings (15,551,167 ft.2) metered for total energy and 46 buildings (10,414,484 ft.2) metered for

water use. Not every building is included, as many are not monitored. The Facilities Services Department provided supplemental information including building space and conservation programs.

After obtaining these energy and water data and verifying with the FS website, errors in building names or total space from the Dashboard were corrected (see Table 8).2 This report excludes cooling tower data and buildings such as the Thermal Energy Storage (TES) building, as they have no regular occupants. UEM provided the campus base map to campus-wide building consumption. Data for total energy and domestic water consumption were used with the base map in ArcGIS software to produce the 2011-13 Building Sustainability Indices.

Table 5: UT's National Comparison Group of Universities.

National Comparison Group (NCG)				
Count	Institution Name	Short Name	State	Control
1	University of California-Berkeley	UC Berkeley	California	Public
2	University of California-Los Angeles	UCLA	California	Public
3	University of California-San Diego	UC San Diego	California	Public
4	University of Illinois at Urbana-Champaign	Illinois	Illinois	Public
5	Indiana University-Bloomington	Indiana	Indiana	Public
6	University of Michigan-Ann Arbor	Michigan	Michigan	Public
7	Michigan State University	Michigan State	Michigan	Public
8	University of Minnesota-Twin Cities	Minnesota	Minnesota	Public
9	University of North Carolina-Chapel Hill	North Carolina	North Carolina	Public
10	Ohio State University-Main Campus	Ohio State	Ohio	Public
11	Pennsylvania State University-Main Campus	Penn State	Pennsylvania	Public
12	Purdue University-Main Campus	Purdue	Indiana	Public
13	University of Washington	Washington	Washington	Public
14	University of Wisconsin-Madison	Wisconsin	Wisconsin	Public
15	*University of Texas at Austin*	*UT Austin*	*Texas*	*Public*

Source: "Publications." Publications. The University of Texas - Austin, 2015. Web. 5 Feb. 2015. < https://www.utexas.edu/reporting/publications#ut-comparison-group>.

Table 6: List of Publications Comparing University Conservation.

List of Publications Comparing University Conservation		
Title	Year	Source
Climate Action Plan	2008	http://sustainability.ucsd.edu/_files/UCSD_Climate_Action_Plan_12-08.pdf
Sustainability Assessment Report	2008	http://aps-web.ucsd.edu/sustainability/FM/PDFs/UCSD_2008_Sustainability_Assessment_Report.pdf
Water Action Plan	2013	http://aquaholics.ucsd.edu/_files/wateractionplan.pdf
Drought Action Plan	2014	http://aquaholics.ucsd.edu/_files/ucsandiegodroughtactionplan.pdf
UC Annual Sustainability Report	2014	http://ucop.edu/sustainability/policies-reports/reports-awards-rankings/index.html
MSU Sustainability Report	2014	http://sustainability.msu.edu/report/2014/#/
Campus Master Plan	2012	https://www.utexas.edu/operations/masterplan/documents/MasterPlan20130509.pdf

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Table 7: Peer University Comparison of Observed Conservation Practices.

Peer University Comparison of Observed Conservation Practices			
Category	UT	UCSD	MSU
Background	51,313 enrolled; 19M GSF	31,502 enrolled; 19.4M GSF	50,085 enrolled; 22.9M GSF
Goals	Reduce energy and water by 20%, 2020	annual 4% water reduction; 20% by 2020	reduce energy 20% by 2020
Initiatives	8 engagement; 4 technical	1 engagement; 4 technical	3 engagement; 9 technical
LEED	2M GSF	23 building certifications	1.6M GSF certified; 10 buildings
Dashboards	Indusoft and Enurgy	Energy Dashboard	Energy Display
Progress	Energy reduction 17.5%	4% annual water reductions;	energy increased 0.1 kWh/ft.2; and challenge reduction is 14%
GSF = gross square feet			

Sources: “Get Involved with Be Spartan Green | Michigan State University." Get Involved with Be Spartan Green | Michigan State University. Michigan State University, 2015. Web. 8 May 2015. < http://www.bespartangreen.msu.edu/get-involved.php>.

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Table 8: Building Corrections and Assumptions.

Building Corrections and Assumptions					
ID	Name	Alias	Original	Corrected	Assumed Type
POB	Peter O'donnell Jr. Building	n/a	35,000	181,805	E&G Lab
CSB	Clark Field Support Building	Caven Clark Field Support Building (CLK)	35,000	1,593	AUX Other
NST	NanoScience and Tech Building	Larry R. Faulkner Nano Science and Tech Building (FNT)	35,000	69,394	E&G Lab
SHD	Simkins Hall Dormitory	Creekside Residence Hall (CRH)	35,000	39,649	n/a
SOF	Telecomm.svc.satellite Ops Facility	n/a	10,000	300	AUX Other
GRG	Geography Building	Black and Latino Studies Building (BLS) or Gordon-White Building (GWB)	31,737	n/a	n/a

Sources: “Building Details: Main Campus." Peter O'donnell Jr. Building. Office of the Vice President for University Operations, 1 Feb. 2015. Web. 1 May 2015. < https://www.utexas.edu/facilities/buildings/UTM/0224>.

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Chapter 5: Peer University Comparison: UT, UCSD, and MSU

This chapter compares energy and water conservation practices at The University of Texas at Austin (UT) with two peer universities, the University of California-San Diego (UCSD) and Michigan State University (MSU). Each of these three universities uses a combined heat and power (CHP) plant, maintains a micro-grid power infrastructure, and provides power primarily to the campus. The chapter is organized in sections for each university. A summary comparison will address each university's technical efforts and campus engagement for the built environment including background, goals, initiatives, LEED, dashboards, and progress.

The University of Texas-Austin (UT)

UT enrolled 39,523 undergraduate and 11,790 graduate students as of 2014 (51,313 total).1 The campus is located on 434 acres.2 UT owns or leases 639 buildings.3 There are approximately 229 buildings on the main campus.4 UT maintains about 19 million gross square feet (gsf) of space.5 UT produces power through its 140-megawatt (MW) Carl J. Eckhardt combined heat and power (CHP) plant.6 UT purchases its water from the City of Austin.

UT's 2012 Campus Master Plan outlines an energy conservation goal of 20% of its energy and water by 2020, in comparison to a 2009 base year.7 Table 9 lists UT initiatives to achieve these goals.

One example of an initiative, Building Recommissioning, is conducted as a building audit and follow-up implementation of energy and water conservation measures, resulting in a 25 percent energy avoidance in new buildings.8 The Horns Up, Sash Down program encourages laboratory building occupants to keep fume hoods below 10 percent

while not in use. In the fall of 2014, 284 fumes hoods had an average reduction of $74.30 in energy savings which could lead to over $21,000 annually if maintained consistently.9 The High Energy Response Operators (HERO) program encourages staff to conserve total energy; a 'winning' set of participating buildings conserved 3.8 percent during Q4 FY2013-2014.10

Longhorn Lights Out is a campus engagement initiative among faculty, staff, and students to unplug unnecessary loads for a specific date, saved over 62,000 kWh since it commenced.11 The Computer Power Management Program monitors one thousand computers' power consumption and saved over 700,000 kWh from March 2009-2014.12 The Holiday Scheduling initiative powers down appliances during dates when occupancy is minimal on campus; it saved 8,624 mm BTU during 17 days of the last winter break.13 The Campus Conservation Nationals is a university competition to save power during two weeks in April 2015. An Irrigation Project managed by Landscape Services consists of a central irrigation system for checking for leaks and monitoring consumption that saved over 100 million gallons annually since implementation.14

At UT, all new buildings are constructed to achieve a Leadership in Energy and Environmental Design (LEED) Silver rating.15 Existing buildings overseen by Project Management and Construction Services will follow green renovations once guidelines are complete.16 UT currently has over 2,000,000 gross square feet (gsf) of LEED projects either completed or in the design phase.17

The Utilities and Energy Management (UEM) collects and displays energy and water consumption data through its Indusoft Dashboard, UT's hub for building consumption.18 The Dashboard tracks consumption data on an annual, monthly, and daily basis for electric power, chilled water, steam, and domestic water in campus buildings.

Data are represented in charts and available for download to any user who has access through UEM. UEM uses the Enurgy Dashboard for calculations and reporting.19

UT has reported in its current EWC Conservation Scorecard that as of 2015 the EUI is 17.5 percent lower than the base year of 2009.20 Though there is no official mention of a domestic water use index, there are data for metered buildings from Sept. 2012 to Aug. 2013.21 The Campus Baseline spreadsheet suggests that total annual water use (from buildings, the power plant, chilling stations, and landscaping) has fallen from 885,000 thousand gallons (k-gallons) in 2009 to 619,000 k-gallons in 2013.22

The University of California-San Diego (UCSD)

UCSD's latest enrollment includes 24,810 undergraduate, 4,849 graduate, and 1,842 pharmacy/medicine students (31,502 total) as of 2014.23 Its campus area is 1,976 acres. 24 UCSD has 769 buildings and 19.4 million gsf.25 The university is powered by multiple sources including: a 30-MW CHP plant (it provides about 85% of the demand); a 1.5-MW solar power network; a 300-kilowatt (kW) solar thermal water-heating system; and a 2.8- MW fuel cell which supplies 8% of the demand.26 UCSD is San Diego's third largest consumer of water.

UCSD is currently faced with extreme drought conditions and has adopted a 2014 Drought Action Plan shortly after a December 2013 Water Action Plan.27 There are conservation goals that had been met previously against a 2008 baseline, including an annual 4 percent reduction goal that was kept in the new plan.28 The 2014 Plan aims to reduce 20 percent by 2020 compared to the base years 2010-2012.

Currently, 30 percent of UCSD's irrigation comes from recycled water; drought-tolerant plants cover 75 percent of irrigated campus grounds. Retrofits of standard sprinklers saved 10 million gallons per year. A computer-based irrigation system saves 55

million gallons per year.29 The Drought Plan lists 17 additional projects that would save a projected 34 percent water consumption.30 Renewable energy production consists of a 1.5 megawatt (MW) solar network and a 2.8 MW fuel cell that provides 8 percent of campus needs.31 Table 10 lists the initiatives related to energy and water conservation.

UCSD has announced a policy that all new buildings will be LEED Silver rated or better; it now has 23 total building certifications in existing or construction conditions.32 There are 25 buildings are undergoing retrofits worth $73 million.

UCSD uses an Energy Dashboard available online to provide real-time data for most buildings on campus, complete with an interactive map and research resources.33 It is attributed to reducing energy costs by $900,000 and consumption by 19 million kWh annually.34 The Energy Dashboard is part of an Energy Management System that improves efficiency by allowing plant operators to monitor and control heating, ventilation, and air-conditioned equipment.35

UCSD's Facilities Management Department has predicted that it can decrease campus energy demand by 300 kW/year and consumption by 4,000,000 kWh/year.36 Previous water conservation goals had been met, leading to revised goals in 2012.

Michigan State University (MSU)

MSU enrolled 37,786 undergraduate and 11,299 graduate students (50,085 total) as of 2014.37 MSU owns 1,199 buildings on a 5,192-acre campus.38 They maintain 547 buildings and 22.9 million gsf.39 The 100-MW T.B. Simon Power Plant provides power, heat, and steam for the campus.40 The plant can use natural gas, biomass, or coal. MSU produces the majority of its water from wells, and purchases a smaller proportion from the City of Lansing.41

MSU has committed to reducing 20% of its Energy Use Index by 2020 in its 20 million square feet. 42 The MSU campus, a Better Buildings Challenge participant, is engaged in reducing energy consumption. The Infrastructure Planning and Facilities Department leads conservation practices. Energy conservation measures are grouped by the cost to enact them including: low-cost, fast-payback measures; 3-5 years payback measures; and long-term payback measures.43 Energy consumption is monitored by the Building Automation System.44 Five Energy Teams compose the facilities aspects of conservation.45 The Energy Use Reduction Incentive Program aims to engage units to conserve. Currently there are building commissioning projects underway, but more strategies are being planned.46

MSU has established a Pledge to Be a Green Spartan; students can sign up for the program, although measurements of impacts do not exist.47 Spartan Green Certifications are available for functional units of the campus, including laboratories, offices, and individual living spaces to improve: energy efficiency and conservation, waste reduction and recycling, water conservation, and sustainable purchasing practices.48

The Integrated Campus Water Systems Mapping Project covers water conservation initiatives as MSU produces the majority of its own water.49 MSU has adopted water conservation practices such as drip irrigation systems for campus plants and replacing old fixtures for more efficient ones are two such initiatives.50 Table 11 lists MSU's observed efforts.

MSU has built over 1,559,273 square feet of LEED certified existing space, including four Gold certifications, and six Silver certifications since 2009.51

MSU's Energy Dashboard displays building information for available metered flows and includes water, hot water, steam, cooling, electricity, carbon dioxide emissions

estimates, and their energy utilization index.52 The dashboard provides real-time information for building comparisons for any user on the website.

MSU produced a Sustainability Report for 2014, found online as an executive summary.53 It reports that electricity consumption in the built environment of 538 buildings has increased from 13.6 to 13.7 kWh/ft.2 since 2009.54 Total energy consumption has increased compared to 2009. However, in the Better Buildings Challenge, MSU has achieved a reduction of 14 percent to date.55

Summary Comparison

The conservation information for UT, UCSD, and MSU found online is not exhaustive and does not include unpublicized programs. The three peer universities differed in their resources and size. MSU is reducing building energy consumption across its 20 million square feet of space while not aggressively reducing water use, perhaps because it produces its own water supply. UCSD focuses on water reduction while it aims for carbon neutrality and increasing its renewables portfolio. UT focuses on both energy and water conservation. Table 12 compares the practices of the campuses.

One of the challenges of web-based research is that only self-reported initiatives related to energy and water conservation or building performance are listed. UT showed the most engagement activities actively pursued. MSU shows the most technical initiatives.

The three universities showed comparable certification achievements. UCSD reported that it follows 15 best practices in building, including maintaining Green Building Baseline Scorecards on all new buildings.56

Each campus energy and water dashboard is used as a work in progress. UT includes domestic water consumption unlike UCSD and MSU. UT's data are not publicly accessible yet and are not as visually appealing as MSU's. MSU and UCSD both have

resource links on the website. UCSD's navigation and links have not been maintained in recent years.

The universities altogether report some form of progress, but detailed methodologies require more research. MSU showed contradictory progress as its Sustainability Report provided information of an increasing energy use index, yet the Better Buildings Challenge reports it has reduced 14 percent energy consumption.57 This may be because of different reporting measurements. A peer class or methodology for comparing universities may be beneficial for identifying performance.

UT does not have an annual sustainability or conservation report. University of California campuses are each included in a UC Annual Sustainability Report, showing campus-to-campus trends that can be compared.58 MSU provides its report with similar trends for energy and water conservation. Though it does not mention comparisons with other peers, MSU's Better Building Challenge calls for its campus to reduce consumption in competition with 9 other universities. This is an example of campus-wide engagement. UCSD showed active participation as it met and refined its water conservation goals. Irrigated areas are now 75% drought tolerant vegetation, and they measure conservation on a per capita basis.

The practices observed give a general perspective of differences between UT and the two peer institutions with best practices providing a comparison to UT's practices current. The next chapter reviews conservation on the UT campus. The final 'Recommendations' chapter brings together the points from the Peer University Comparison and UT Building Consumption chapters.

Table 9: UT Conservation Initiatives.

UT Energy and Water Conservation Initiatives	
Campus Engagement	Technical/Studies
Horns Up, Sash Down	Irrigation Project
The High Energy Response Operators	Building Recommissioning
Longhorn Lights Out	Building Automation Systems Analysis
Computer Power Management Program	Building Optimization Team
Holiday Scheduling	
Campus Conservation Nationals	
Ultra Low Freezer Program	
UT Conserve App	

Sources: "Energy & Water Conservation Program (EWC)." Energy & Water Conservation. Office of the Vice President for University Operations, 1 Feb. 2015. Web. 7 May 2015. < https://www.utexas.edu/facilities/EWC/ >.

"Building Operations." Building Operations. Office of the Vice President for University Operations, 1 Feb. 2015. Web. 8 May 2015. < https://www.utexas.edu/facilities/divisions/maintenance/building-operations.php >.

Table 10: UCSD Conservation Initiatives.

UCSD Conservation Initiatives	
Campus Engagement	Technical/Studies
Green Office Certification	Energy Management System Recycled Water Irrigation Xeriscaping Energy Efficiency Partnerships

Sources: "What You Can Do." UC San Diego Sustainability Resource Center. UC San Diego, 2015. Web. 8 May 2015. <http://aps-web.ucsd.edu/src/whatyoucando.html >.

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Table 11: MSU Conservation Initiatives.

MSU Conservation Initiatives	
Campus Engagement	Technical/Studies
Better Buildings Challenge	Building Automation System
Pledge to Be a Green Spartan	Spartan Green Certifications
Energy Use Reduction Incentives	Integrated Water Systems Mapping
	Scheduling
	Economizer/Outside Air Controls
	Set Point Changes
	Load Reduction
	Reset Schedules

Sources: “Get Involved with Be Spartan Green | Michigan State University." Get Involved with Be Spartan Green | Michigan State University. Michigan State University, 2015. Web. 8 May 2015. < http://www.bespartangreen.msu.edu/get-involved.php>.

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Table 12: Comparison of Peer University Conservation Practices

Comparison of Peer University Conservation Practices			
Category	UT	UCSD	MSU
Background	39,979 enrolled; 19M GSF	23,805 enrolled; 19.4M GSF	37,988 enrolled; 22.9M GSF
Goals	Reduce energy and water by 20%, 2020	annual 4% water reduction; 20% by 2020	reduce energy 20% by 2020
Initiatives	8 engagement; 4 technical	1 engagement; 4 technical	3 engagement; 9 technical
LEED	2M GSF	23 building certifications	1.6M GSF certified; 10 buildings
Dashboards	Indusoft and Enurgy	Energy Dashboard	Energy Display
Progress	Energy reduction 17.5%	4% annual water reductions;	energy increased 0.1 kWh/ft.2; and challenge reduction is 14%
GSF=gross square feet			

Sources: “Get Involved with Be Spartan Green | Michigan State University." Get Involved with Be Spartan Green | Michigan State University. Michigan State University, 2015. Web. 8 May 2015. < http://www.bespartangreen.msu.edu/get-involved.php>.

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Chapter 6: UT Buildings Consumption

The University of Texas at Austin (UT) measures its conservation primarily by its energy and water reductions in the built environment.[1] This chapter presents an analysis of all buildings for total energy and domestic water consumed based on continuous meters from 2011-2013, including both E&G and Auxiliary spaces. Water consumption on landscapes including irrigation was outside the scope of this thesis. As of 2011, installed meters were calibrated and treated as "revenue-grade."[2] Data prior to 2011 are excluded from this report. Outlier buildings that reported over 200 percent energy increases and 1,000 percent water increases were excluded. Names and acronyms, and some gross square feet (gsf) measurements were corrected by referring to the Facilities Services updated website. Appendices C and D list consumption raw data.

There were 15,511,167 ft.^{2} metered for total energy (64% E&G and 36% Auxiliary). There were 10,414,484 ft.^{2} metered for water (76% E&G and 24% Auxiliary). As seen in Figure 5, energy use dropped 10% from 0.175 to 0.157 mm BTU/ft.^{2} throughout the building selection. E&G spaces reduced 11% while Auxiliary reduced 6%. For example, the E&G type Engineering Teaching Center reduced from 0.2623 to 0.1986 mm BTU/ft.^{2} (24% reduction). Domestic water for the campus decreased 4%. E&G buildings reduced 9% and Auxiliary spaces increased use by 1% (see Figure 6). For example, the Auxiliary type Gregory Gymnasium reduced water use from16.6 to 15.1 K-gallons/ft.^{2} (9.3% reduction). One trend is the superior conservation performance of aggregated E&G spaces versus aggregated Auxiliary spaces.

There are multiple building categories in both E&G and Auxiliary space types. After removing extreme outliers, E&G categories still reduced more energy and water per square foot. The summary statistics of energy and water conservation from 2011-13 are

seen in Table 13. In 22 out of 68 E&G buildings, energy consumption increased from 2011. In 2013 approximately half of the Auxiliary buildings increased energy consumption. The highest average reduction for energy came from E&G Office buildings with 19%. For Auxiliary spaces, Public Assembly was highest with an average reduction was 6%.

With the campus base map provided by UEM, consumption data were entered and displayed as ten natural break classifications in graduated colors to create the UT Building Sustainability Index. This method produced reductions for indices for energy and water conservation in each building. The indices rank each building on a scale of 1-10, based on reduction performance. A challenge in the mapping is that the building names may be projected in a format too small to identify.

The green shades represent highest reductions while darker red represents higher energy use and darker blue represents higher water use (see Figures 7-8.) For example, the Student Activity Center showed an orange hue representing a 28% increase (rank 2) in energy use and the Anna Hiss Gymnasium with a bright green showed a 78% water use reduction (rank 10). The total energy and domestic water reductions compared to 2011 are shown as percentages. These maps are based on the same data as the previous Figures 5-6 and identify the best and worst building performance. The average energy reduction on the metered campus was 6%.

The initial 2012-13 EWC Annual Executive Report measured reductions for E&G spaces in which there were conservation measures implemented.3 The most recent publication, EWC Q3 2014 Executive Overview, shows an energy reduction of 17.5 percent (see Figure 9).4

This updated report includes additional E&G spaces that did not undergo any conservation programs.5 While the EWC Reports focus on E&G space (office, public assembly, multi-use, lab, computing, academic), this analysis considers all available data

for observation, which includes Auxiliary space (public assembly, parking, office, multi-use, food service, and dormitory). Utilities and Energy Management produced analyses on power plant efficiency that showed conservation despite campus growth (see Figure 10).6 This shows historical fuel usage, energy production, and plant efficiency of the Carl J. Eckhardt Heating and Power Complex.

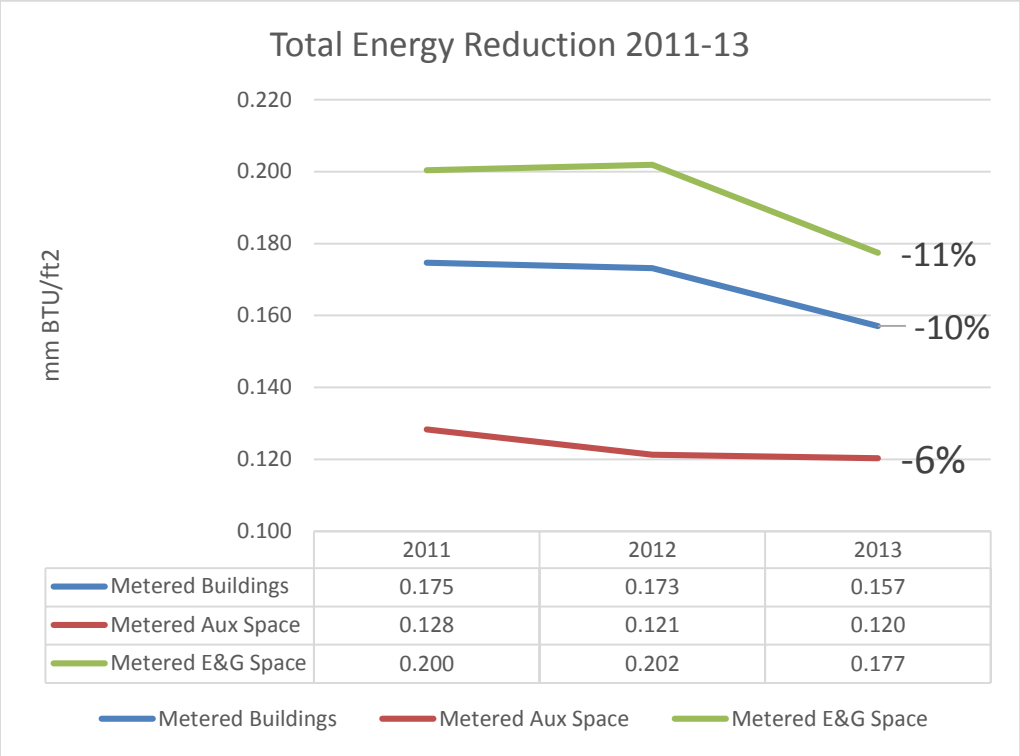
This report shows that a comprehensive building consumption analysis is feasible. Future research could include grounds and landscaping consumption as a component of the campus. For example, outdoor lighting and irrigation are two regular uses found outside buildings. Expanding meters would provide a more accurate understanding of the built environment, but integrating Landscape Services and UEM operations may be beneficial to address the entire campus' needs. The data discussed stem from the observations of UT's self-evaluation methodologies with the aim of including more data in the near future. Recommendations made are based on these observations and the best practices of peer universities.

Table 13: Reduction Summary by Building Category.

Reduction Summary by Building Category				
Total Energy	**E&G**	**Average**	**Minimum**	**Maximum**
	Academic	0%	-35%	85%
	Lab	-12%	-49%	18%
	Office	-19%	-86%	28%
	Public Assembly	-13%	-85%	32%
	Auxiliary	**Average**	**Minimum**	**Maximum**
	Dormitory	11%	-36%	95%
	Multiuse	3%	-44%	56%
	Public Assembly	-6%	-54%	13%
Domestic Water	**E&G**	**Average**	**Minimum**	**Maximum**
	Academic	32%	-71%	756%
	Lab	12%	-41%	172%
	Office	107%	-28%	350%
	Public Assembly	13%	-92%	215%
	Auxiliary	**Average**	**Minimum**	**Maximum**
	Dormitory	28%	-34%	230%
	Multiuse	7%	-15%	34%
	Public Assembly	15%	-9%	96%
Key: Reductions in consumption are listed as percent changes from base year 2011. Negative values are reductions, and positive values are increases.				

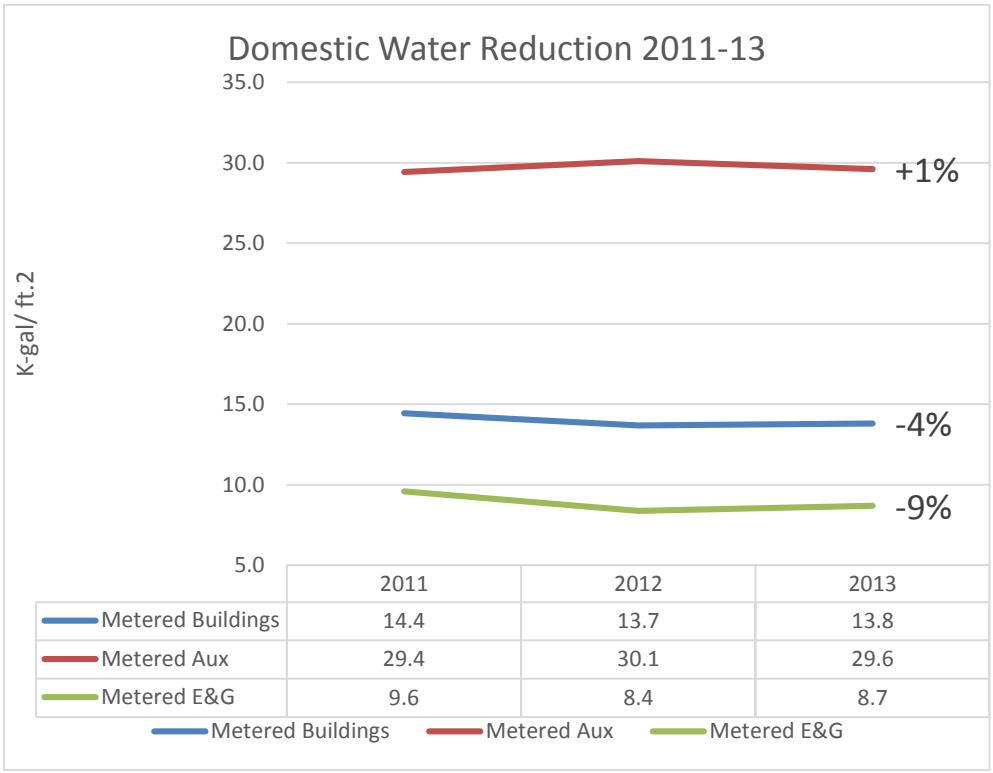
Source: May 8, 2015. Collected and reported in an unpublished study by Oscar Garcia, 2015.

Figure 5: Total Energy Consumption for Metered Campus 2011-2013.



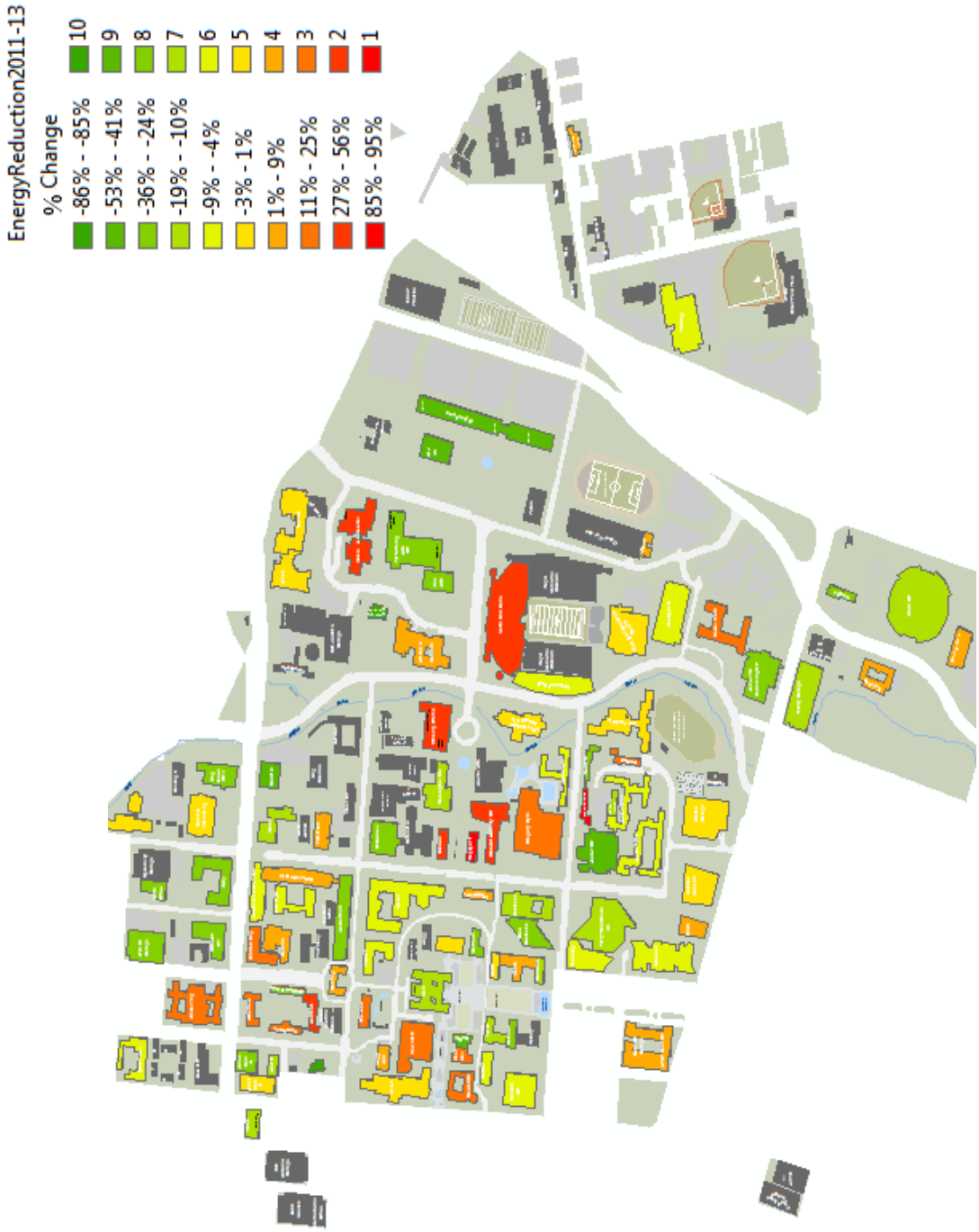
Source: May 8, 2015. Collected and reported in an unpublished study by Oscar Garcia, 2015.

Figure 6: Domestic Water Consumption for Metered Campus 2011-2013.



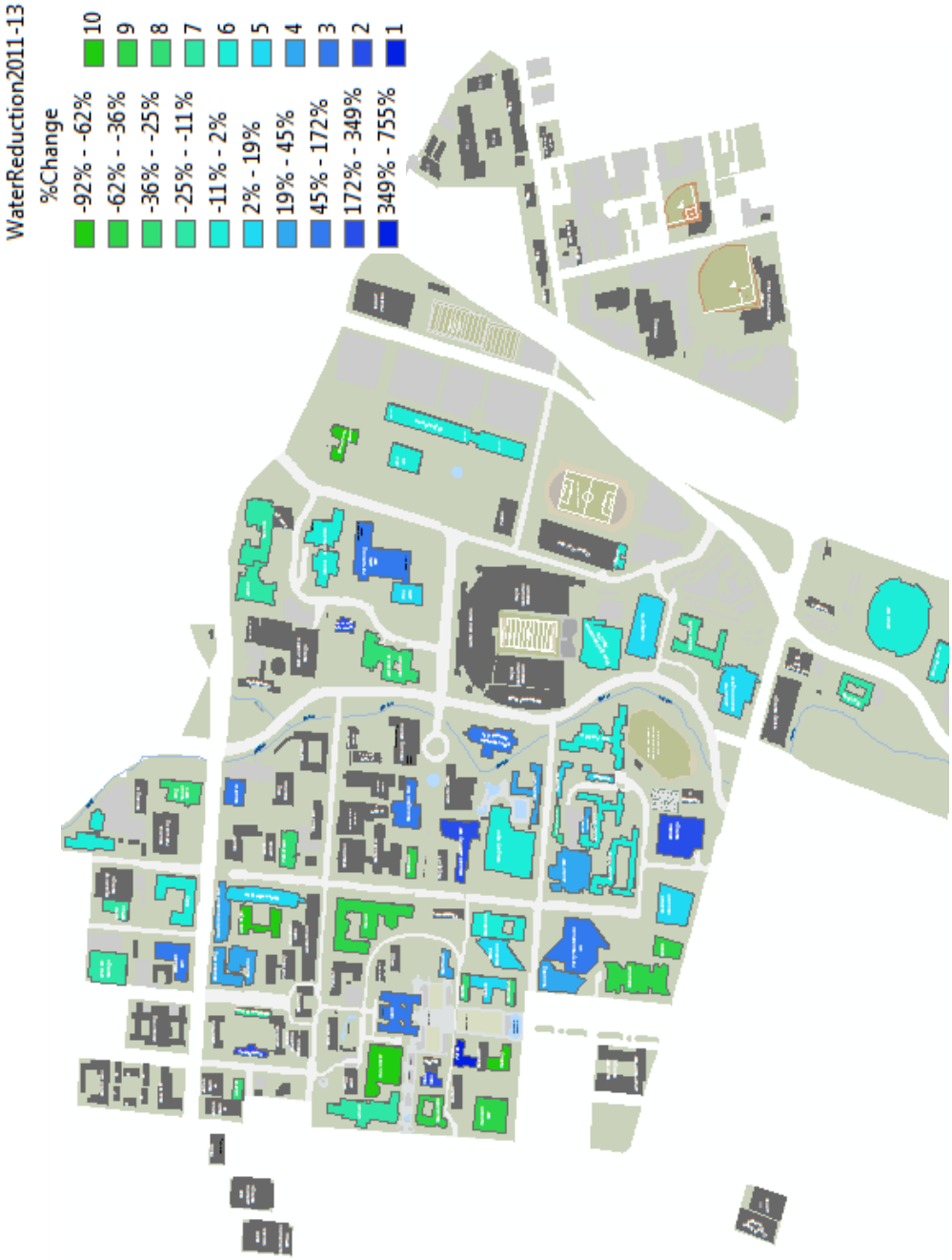
Source: May 8, 2015. Collected and reported in an unpublished study by Oscar Garcia, 2015.

Figure 7: Percent Total Energy Reductions by Building for 2011-13.



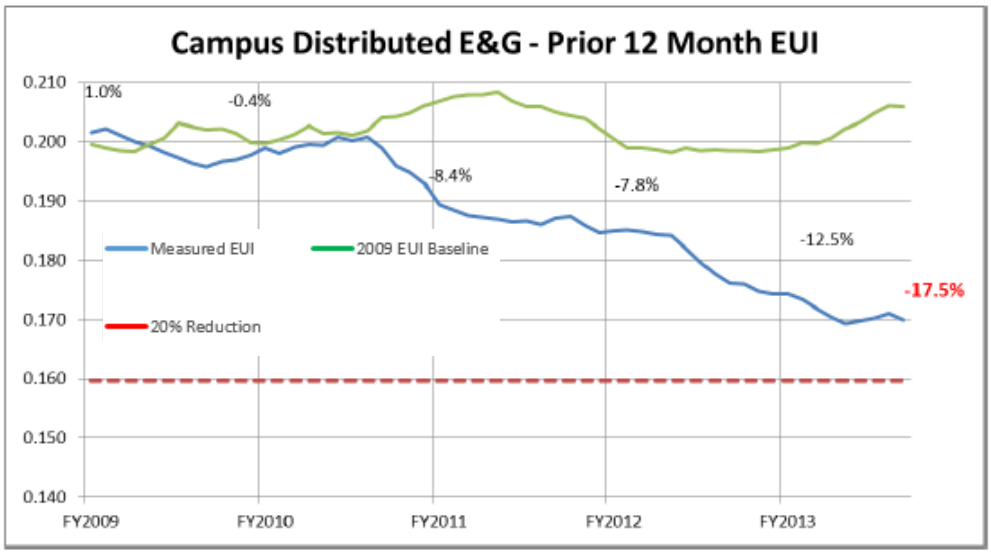
Source: May 8, 2015. Collected and reported in an unpublished study by Oscar Garcia, 2015.

Figure 8: Percent Domestic Water Reductions by Building for 2011-13.



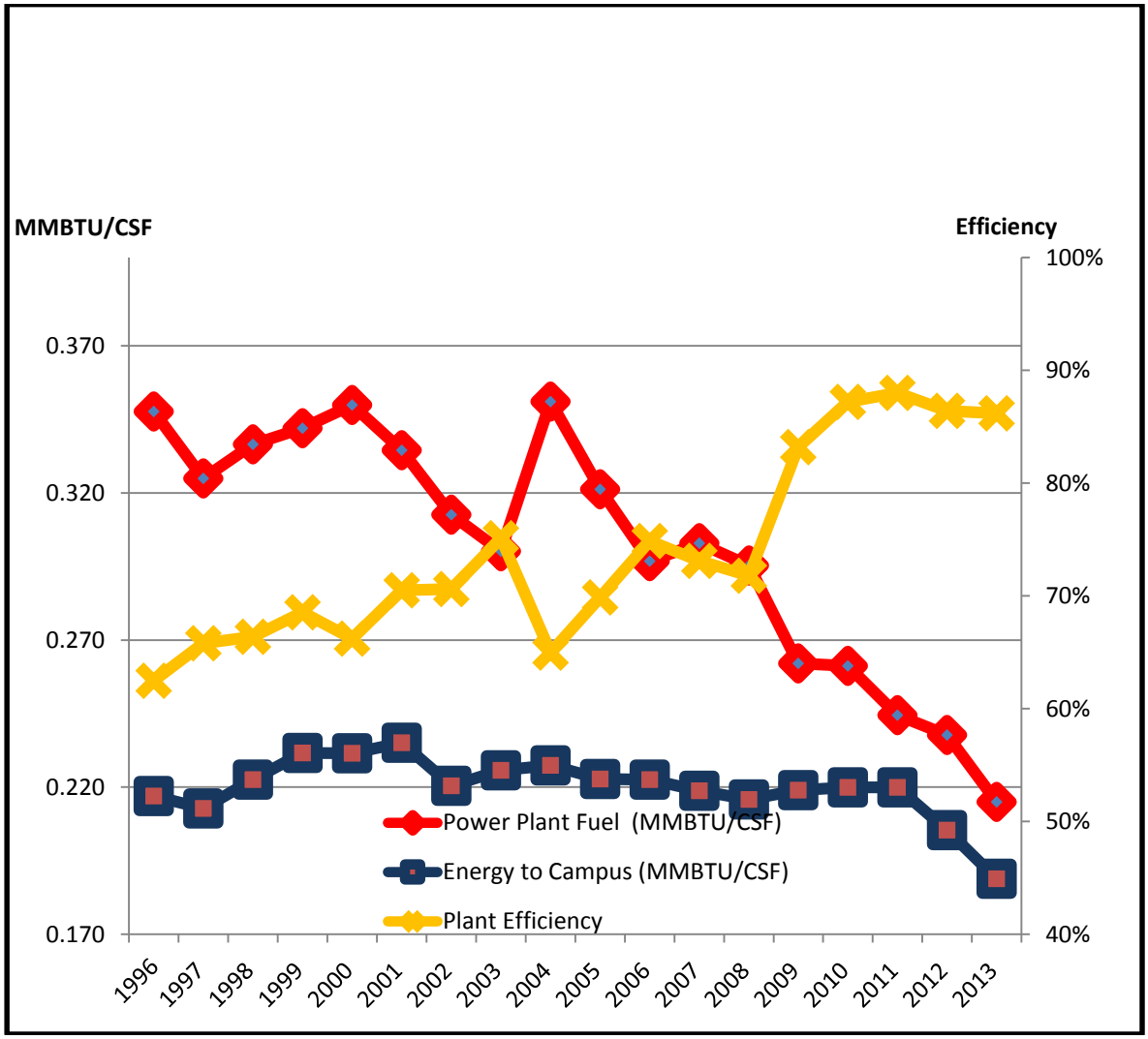
Source: May 8, 2015. Collected and reported in an unpublished study by Oscar Garcia, 2015.

Figure 9: EWC Campus Distributed E&G.



Source: Energy & Water Conservation Executive Overview. Digital image. 1 May 2014. Web. < https://www.utexas.edu/facilities/EWC/index.php#about>.

Figure 10: Power Plant Efficiency.



Source: Ontiveros, Juan. Energy Data. Spreadsheet. May 6, 2015.

Chapter 6 References

[1] "Energy & Water Conservation Program (EWC)." Energy & Water Conservation. Office of the Vice President for University Operations, 1 Feb. 2015. Web. 27 Apr. 2015. < https://www.utexas.edu/facilities/EWC/ >

[2] Ontiveros, Juan Personal meeting. May 14, 2015.

[3] Ontiveros, Juan and Tejas Pevekar. Personal meeting. May 6, 2015.

[4] Energy & Water Conservation Executive Overview. Digital image. 1 May 2014. Web. < https://www.utexas.edu/facilities/EWC/index.php#about>.

[5] Ontiveros, Juan and Tejas Pevekar. Personal meeting. May 6, 2015.

[6] Ontiveros, Juan. Energy Data. Spreadsheet. May 6, 2015.

Chapter 7: Recommendations

A total of 17 recommendations are made to be carried out by four different responsible parties (see Table 14). The four parties discussed are: Energy and Water Conservation Program (EWC); The UT President's Sustainability Steering Committee (PSSC); Utilities and Energy Management Department (UEM); and Landscaping Services team (LS). Each recommendation is organized by anticipated length of time required to accomplish it. Short term recommendations are given 6 months to 1 year; medium term can be accomplished in 1 to 2 years; and long term in 2-3 years.

Table 14: Recommendations List.

Recommendation	Responsible Party
Short Term (6 months-1 year)	
Assess conservation behavior status of students, faculty, and staff	EWC
Develop UT consumption standards or metrics on a per capita basis	EWC
Establish Residence Hall Stewards/Portfolio Managers	EWC
Account for all metered buildings in calculations	EWC
Commit to Energy Star Portfolio Manager	EWC
Develop Sustainability Peers List	PSSC
Medium Term (1-2 years)	
Improve planning components to the EWC Reports	EWC
Renew and/or publicize commitments broadly	PSSC
Sign the ACUPCC	PSSC
Add smaller, annual conservation milestones	PSSC
Improve the Dashboard system and interface for public access	UEM
Communicate with Battle Hall Dashboard creators	UEM
Research co-benefits of conservation	UEM
Long Term (2-3 years)	
Then begin a Climate Action Plan	PSSC
Revolving Sustainability Fund	PSSC
Install meters in every building	UEM
Xeriscaping Project	LS
Key: EWC (Energy and Water Conservation Program) PSSC (President's Sustainability Steering Committee) UEM (Utilities and Energy Management) LS (Landscaping Services)	

Source: May 8, 2015. Collected and reported in an unpublished study by Oscar Garcia, 2015.

Short Term

The Energy and Water Conservation Program (EWC) of the Facilities Services Department could establish a number of performance measures in a short time period, less than a year. One step could be a campus survey of sustainability or conservation literacy which could be administered by email. Such a survey could ask areas of conservation that need more attention and what priorities stakeholders need addressed.

The EWC could develop new standards for water consumption in gallons per capita per day (GPCD) or energy use in BTU per day for UT buildings and for students, faculty, and staff. Just the existence of energy and water use targets would raise awareness and participation in current EWC initiatives. Such a target was developed by The University of Copenhagen and has been used in other universities around the globe.1 Each building category could have its own standard weight to normalize for the expected amount of energy or water used. For example, Lab buildings could have a higher factor for energy use than Office buildings.

Despite efforts to standardize energy and water consumption analysis at UT, the EWC is not yet able to account for all available data using consistent measurements and metrics. Collaboration with the Utilities and Energy Management department (UEM) is crucial to accessing and analyzing data. Data ought to be available for access even if they are not publicized.

UT may be able to benefit from the Energy Star Portfolio Manager tool. Students could collect water and energy data from their dormitories and register them in the Energy Trends Report.2 Administrators and students could follow this patterns of energy and water use in every campus building and open space, which could help improve every residence hall's building performance engage campus stakeholders.

The President's Sustainability Steering Committee (PSSC) ought to confirm a UT Peer List for Sustainability Comparison for future inter-university comparisons. Analogous to the National Comparison Group, this list would include universities of similar energy and water resource circumstances and allow for friendly competition.

Medium Term

There are seven recommendations to be addressed during the next 1-2 years by three responsible parties. The EWC ought to remain enact planning components to its activities; the PSSC could publicly re-commit to its efforts; and the UEM could set to improve its energy dashboards.

One component to add to the EWC reporting is regular performance updates. The updates could include such topics as new projects, respective methodologies, and identification of strengths, weaknesses, opportunities, and threats. This transparency ought to be available to other departments.

UT could renew and publicize its sustainability commitments. Currently, the Clinton Global Initiative-University does not list UT on its network for the past three years of commitments.3 UT could consider to committing to the Universities Pricing Carbon and The Climate Registry initiatives.

The ACUPCC could be signed for a long term goal of pursuing carbon neutrality. UT has already completed a greenhouse gas inventory in 2009 and could aim to reach the ACUPCC goals with gains from conservation and efficiency measures.

UT could implement smaller achievement goals in its operations to increase engagement. One type could be annual conservation goals in addition to those set for 2020. For example, a 5 percent annual reduction goal would benefit the university's preparedness. This could be divided into the different sectors of total water consumption

on campus. Annual energy reduction goals could be established for multiple operations departments.

The Indusoft and Enurgy Dashboards could be made to be widely accessible for the UT community. Upgrading these tools would be beneficial for research opportunities, reporting of initiatives, and for evaluating conservation measures. Collaboration with the Battle Hall group could benefit from their experience in having a functioning dashboard for their building.

Studying co-benefits and other techniques for harnessing savings could benefit UT in direct savings. For example, recovered water has been returning flows to the plant for decades, but capturing evaporation is definitely worth studying.4 Allocating funding towards conservation research could improve current strategies.

Long Term

Recommendations for implementation during the next 2-3 years include two policy approaches and two operational approaches. The first three expand current conservation efforts. The fourth long term recommendation consists of changing the irrigation component at UT.

UT does not have a Climate Plan or a Sustainability Plan. Its primary focus of sustainability operations is conservation. The EWC reports and the Campus Master Plan have piecemeal attempts at sustainability planning. A Sustainability Plan ought to be created by the PSSC

EWC initiatives are sometimes funded by student-paid Green Fee grants, a financial commitment is warranted. Revolving energy funds like the one suggested by Kleberg are just as vital to reductions as the management system itself. With similar criteria to Green Fee grant applications, a revolving financial tool could sustain funding for future

projects. This could be competed for amongst departments, or each department could create its own revolving fund.

UEM could continue to install meters throughout the campus for data monitoring. An annual goal of installations could increase the rate of deployment. The meters ought to be revenue-grade meters to produce reliable data.

Landscaping Services could enhance its conservation efforts by creating a Xeriscaping Project to increase the amount of drought-tolerant, native plant vegetation on campus grounds, further reducing consumption. Areas that require more irrigation could be targeted in a pilot study initially. Once savings are estimated, expansion could include irrigated grounds that experience the most maintenance.

These recommendations aim to guide UT toward more effective conservation practices and a campus-wide culture of embracing sustainability. Perhaps the most important recommendation is that UT commit to self-report its conservation performance and include peer universities in its evaluation as a means to identify opportunities for progress.

Improvements to this study include collecting more data as it becomes available and other comparable universities. Other factors for consideration in comparisons include budget details and power plant loads. Future work on building consumption analysis could include the expansion of new meters and inclusion of electricity, heating, and cooling energy flows. An integrated map of the campus buildings and grounds with the UEM Indusoft or Enurgy Dashboards could serve as a complete monitoring system.

Chapter 7 References

[1] "Søg / Search." Green Results and Indicators – University of Copenhagen. University of Copenhagen, 2013. Web. 13 Mar. 2015. <http://greencampus.ku.dk/green_results_and_indicators_/>.

[2] "DataTrends: Energy Use in Residence Halls / Dormitories." Energy Star. USEPA, 2015. Web. 11 Mar. 2015. < http://www.energystar.gov/buildings/tools-and-resources/datatrends_energy_use_residence_halls_dormitories>.

[3] "CGI University Network." Clinton Global Initiative University. Clinton Global Initiative, 2015. Web. 26 Apr. 2015. < http://www.cgiu.org/university_network/>.

[4] Looney, Clay. Telephone interview. 1 Mar. 2015.

Appendix A: Guide to Green Colleges Survey

This Appendix lists the survey questions used in the Princeton Review's Guide to 332 Green Colleges. The university's responses are calculated based on responses to these ten equally weighted questions. Although a university is not ranked amongst its peers, it is named in the Guide to Green Colleges if its score surpasses a threshold score (83/99 points in 2014).

No.	**Survey Questions**
1	The percentage of food expenditures that goes toward local, organic or otherwise environmentally preferable food.
2	Whether the school offers programs including mass transit programs, bike sharing, facilities for bicyclists, bicycle and pedestrian plans, car sharing, carpool discount, carpool/vanpool matching, cash-out of parking, prohibiting idling, local housing, telecommuting, and condensed work week.
3	Whether the school has a formal committee that is devoted to advancing sustainability on campus.
4	Whether school buildings that were constructed or underwent major renovations in the past three years are LEED-certified.
5	The school's overall waste-diversion rate.
6	Whether the school has at least one sustainability-focused undergraduate major, degree program, or equivalent.
7	Whether the school's students graduate from programs that include sustainability as a required learning outcome or include multiple sustainability learning outcomes.
8	Whether the school has a formal plan to mitigate its greenhouse gas emissions.
9	What percentage of the school's energy consumption is derived from renewable sources?
10	Whether the school employs a dedicated full-time (or full-time equivalent) sustainability officer.

Source: "Criteria for The Princeton Review Green Rating of Colleges." The Princeton Review's Guide to 332 Green Colleges. The Princeton Review, 2014. Web. 5 Sept. 2014. <http://centerforgreenschools.org/PrinRevGdGreenCols_2014Edn.pdf>.

Appendix B: UT Building Energy Consumption, 1/1/2011 – 1/1/2014

This Appendix lists the energy consumption data for buildings metered between 2011 and 2013. Those buildings that contained errors in the raw data are already corrected here. Total energy used in a building consists of three components: cooling, electrical, and heating. Total energy is measured in MM BTU. The three tables below represents the years 2011, 2012, and 2013. Blank spaces represent data not metered. The date of retrieval is Feb. 3, 2015.

Building Energy Consumption 1/1/2011 - 1/1/2012							
No.	Abbr	Building	SQFT	Total	Cooling	Electrical	Heating
1	WEL	Robert A. Welch Hall	428647.0	213587.5	115440.1	45231.7	52915.7
2	JCD	Jester Dormitory	745671.0	133465.6	76830.4	26360.0	30275.2
3	JES	Beauford H. Jester Center	178997.0	102840.2	28134.4	68986.7	5719.1
4	BMA	Jack S. Blanton Museum Of Art	137522.0	85200.3	37685.1	10262.8	37252.5
5	NMS	Neural And Molecular Science Bldg.	198458.0	81029.9	35474.0	26053.8	19502.0
6	CPE	Chemical And Petroleum Engineering	225939.0	75071.2	41788.1	15820.6	17462.5
7	PCL	Perry-Castaneda Library	492898.0	71145.0	36722.3	18148.1	16274.6
8	ECJ	Ernest Cockrell Jr. Hall	247723.0	65827.1	43123.6	10846.5	11857.0
9	ETC	Engineering Teaching Center	229973.0	60312.8	34933.7	11585.8	13793.3
10	BME	Biomedical Engineering Building	202942.0	58390.4	32946.8	13209.1	12234.5
11	RLM	Robert Lee Moore Hall	393530.0	58152.4	45643.9		12508.6
12	MAI	Main Building	332447.0	57500.4	30634.9	10366.2	16499.3
13	ERC	Frank C Erwin Special Events Center	490153.0	55067.2	23255.5	14238.3	17573.4
14	POB	Peter O'donnell Jr. Building	181805.0	53069.3	28827.8	24241.6	
15	GRE	Gregory Gymnasium	262162.0	52204.6	25490.1	13147.2	13567.3
16	SRH	Sid Richardson Hall	283345.0	50821.5	39567.1		11254.5
17	TSC	Lee & Joe Jamail Texas Swimming Ctr	122122.0	49571.6	33354.2	12275.5	3941.9
18	NST	Larry R. Faulkner Nano Sci And Tech	69394.0	48646.4	11092.7	9060.6	28493.1
19	BEL	L. Theo Bellmont Hall	396712.0	47745.6	31668.5	16077.1	
20	PAC	Performing Arts Center	234662.0	45482.2	25207.8	7450.9	12823.5
21	MBB	Moffett Molecular Biology Bldg.	177216.0	44494.0	25877.7	16078.7	2537.7
22	PAT	J.t. Patterson Labs.bldg.	155882.0	43216.0	22483.6	11811.9	8920.5
23	KIN	Kinsolving Dormitory	243775.0	42203.5	24648.2	9899.6	7655.6
24	UNB	Union Building	167238.0	40666.2	22462.3	10785.4	7418.6
25	JGB	Jackson Geological Sciences Bldg.	199628.0	37357.2	22670.7	9529.3	5157.2
26	SZB	George I. Sanchez Building	258353.0	37175.6	20330.2	6594.9	10250.5

27	ARC	Animal Resources Center	95826.0	37049.9	19605.9	7892.1	9551.9
28	JON	Jesse H. Jones Hall	216050.0	34308.7	23559.2	5222.7	5526.8
29	SJH	San Jacinto Residence Hall	301307.0	33504.1	19730.6	7657.8	6115.7
30	NEZ	North End Zone Building	563782.0	32724.6	16431.5	11207.5	5085.6
31	HRC	Harry Ransom Center	251947.0	32620.4	19885.2	2740.3	9994.9
32	LBJ	Lyndon B Johnson Library	170607.0	30265.8	18737.7		11528.2
33	PAI	T.s. Painter Hall	128536.0	30242.3	16163.9	6601.5	7477.0
34	ATT	At&t Executive Educ & Conf Center	352735.0	29124.5		29124.5	
35	BIO	Biological Laboratories	69799.0	28966.8	16610.4	6498.3	5858.0
36	NHB	Norman Hackerman Building	305224.0	28225.2	9531.3	18693.9	
37	SSB	Student Services Building	194881.0	26280.6	14782.7	8874.9	2623.0
38	FAC	Peter T. Flawn Academic Center	205141.0	26092.7	17209.1	1724.2	7159.4
39	CBA	College Of Business Administration	253863.0	25544.1	18216.1		7327.9
40	ART	Art Building And Museum	157723.0	24440.5	14316.8	4850.1	5273.5
41	SEA	Sarah M. & Charles E. Seay Building	193723.0	24382.4	13999.6	6152.7	4230.2
42	EAS	Edgar A. Smith Building	60096	23182.3	14768.63	2657.97	5755.71
43	GSB	Graduate School Of Business Bldg.	147205.0	22681.2	14433.9	4254.1	3993.3
44	TNH	Townes Hall	167164.0	21879.5	15554.1	689.2	5636.2
45	TMM	Texas Memorial Museum	35018.0	21802.0	1360.3	19984.8	456.9
46	CMB	Jesse H. Jones Comm. Ctr. (Bldg. B)	107730.0	21304.1	3776.7	5165.6	12361.8
47	RSC	Recreational Sports Center	119262.0	21059.6	10732.8	5189.0	5137.9
48	ADH	Almetris Duren Residence Hall	177708.0	20943.1	11727.0	4870.5	4345.6
49	MRH	Music Building & Recital Hall	218016.0	20414.4	11273.0	187.4	8954.0
50	SAC	Student Activity Center	153999.0	20139.8	12018.3	4851.6	3269.9
51	CMA	Jesse H. Jones Comm. Ctr. (Bldg. A)	111795.0	19561.2	10647.6	4390.4	4523.3
52	BUR	Burdine Hall	101555.0	18203.0	8698.0	1520.6	3567.2
53	DFA	E. William Doty Fine Arts Building	91254.0	17454.1	8953.9	3979.1	4521.1
54	UTC	University Teaching Center	169053.0	17013.5	9777.7	3783.9	3451.9
55	NUR	Nursing School	118152.0	16644.9	11005.7		5639.2
56	WIN	F.l. Winship Drama Bldg.	107522.0	16444.2	10848.6	977.3	4618.4
57	WWH	Walter Webb Hall	38173.0	16138.5	3776.7		12361.8
58	MNC	Moncrief-Neuhaus Athletic Center	102422.0	14380.2	9698.4		4681.9
59	MHD	Moore-Hill Dormitory	97370.0	14194.4	8046.9	2963.6	3184.0
60	LTD	Littlefield Dormitory	57334.0	11007.7	6431.5	1632.1	2944.0
61	BLD	Blanton Dormitory	69754.0	10733.6	3852.2	4857.0	2024.4
62	GOL	Goldsmith Hall	85623.0	10355.8	6142.5	1854.9	2358.5
63	SSW	School Of Social Work Building	93460.0	9784.0	4131.3	2471.5	3181.1
64	PAR	Parlin Hall	56137.0	8971.5	4467.4	2750.0	1754.1
65	NOA	North Office Building A	86167.0	8926.7	5925.5		3001.2
66	CAL	Calhoun Hall	55085.0	8897.2	4681.6	2174.6	2041.0
67	RHD	Roberts Hall Dormitory	45086.0	8687.7	6631.3	901.5	1155.0
68	DCP	Denton A. Cooley Pavilion	44564.0	8622.4	4602.2	2144.8	1875.3

69	PPB	Printing And Press Bldg.	83708.0	8400.6		8400.6	
70	LDH	Longhorn Dining Facility	8525.0	8059.9	3933.5	1109.6	3016.9
71	GAR	Garrison Hall	51778.0	7613.0	4209.9	1482.2	1920.9
72	UTX	Etter-Harbin Alumni Center	82939.0	7451.1	4819.1	2632.0	
73	GRG	Geography Building	31737.0	6758.3	3554.0	1356.6	1847.7
74	SUT	Sutton Hall	59498.0	5891.5	4080.3	1559.1	252.1
75	GEA	Mary E. Gearing Hall	60621.0	5883.8	5829.2		54.6
76	WMB	West Mall Office Bldg.	46230.0	5698.7	2590.4	1678.3	1430.0
77	BHD	Brackenridge Hall Dorm	40697.0	5167.4	2618.3	961.7	1587.4
78	PHD	Prather Hall Dormitory	44580.0	4792.5	2693.4	943.3	1155.8
79	CRD	Carothers Dormitory	39648.0	4690.8	2549.2	1204.5	937.2
80	HSM	William Randolph Hearst Bldg	26033.0	4455.3	2358.6	1114.1	982.7
81	COM	Computation Center	14561.0	4338.3		4338.3	
82	BTL	Battle Hall	47191.0	4308.7	4217.1		91.6
83	BRG	Brazos Garage	481961.0	4282.7		4282.7	
84	AND	Andrews Dormitory	41241.0	4010.0	3039.6	970.4	
85	HMA	Hogg Memorial Auditorium	24992.0	3988.1	3988.1		
86	TRG	Trinity Garage	373416.0	3848.6		3848.6	
87	LFH	Littlefield Home	16135.0	3739.5	2162.3	1577.2	
88	MFH	Richard Mithoff Trk/scr Fieldhouse	20372.0	3503.7	2011.3	444.6	1047.8
89	WAG	Waggener Hall	57762.0	3107.4		2880.1	227.3
90	EPS	E.p. Schoch Building	52559.0	3029.5	2466.8	71.9	490.9
91	MEZ	Mezes Hall	91629.0	2459.5		2459.5	
92	BEN	Benedict Hall	38598.0	2441.4		2441.4	
93	CDL	Collections Deposit Library	64749.0	2179.0	869.3	777.5	532.3
94	BRB	Bernard And Audre Rapoport	50846.0	1967.8		1967.8	
95	TSG	27Th Street Garage	214252.0	1713.3		1713.3	
96	UIL	Univ. Interscholastic League Bldg.	34072.0	1541.5		1541.5	
97	MMS	Mike A.Myers Track/Soccer Stadium	16052.0	1348.6		1348.6	
98	BAT	Batts Hall	39143.0	1142.4		1142.4	
99	AHG	Anna Hiss Gymnasium	55240.0	975.7		975.7	
100	HRH	Rainey Hall	54405.0	906.6	576.7		329.9
101	JHH	John W. Hargis Hall	22197.0	823.9		823.9	
102	CSB	Clark Field Support Building	1593.0	178.3		178.3	
103	SHD	Simkins Hall Dormitory	39649.0	4991.5	3998.1		993.5

Source: Utilities and Energy Management Indusoft Dashboard

Building Energy Consumption 1/1/2012 - 1/1/2013							
No.	Abbr	Building	SQFT	Total	Cooling	Electrical	Heating
1	WEL	Robert A. Welch Hall	428647.0	220152.5	126218.5	46473.1	47461.0
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3	ETC	Engineering Teaching Center	229973.0	99009.6	76885.1	11901.1	10223.3
4	BMA	Jack S. Blanton Museum Of Art	137522.0	92449.9	37022.7	9076.2	46351.0
5	NMS	Neural And Molecular Science Bldg.	198458.0	85306.4	38214.9	27549.1	19542.4
6	CPE	Chemical And Petroleum Engineering	225939.0	76044.8	43448.8	15687.3	16908.8
7	PCL	Perry-Castaneda Library	492898.0	66829.0	38225.8	14837.1	13766.1
8	BME	Biomedical Engineering Building	202942.0	64988.0	36491.8	13903.6	14592.6
9	RLM	Robert Lee Moore Hall	393530.0	64535.1	51812.8		12722.3
10	GRE	Gregory Gymnasium	262162.0	60974.1	34427.2	13101.9	13445.0
11	JES	Beauford H. Jester Center	178997.0	58563.9	35699.1	14704.2	8160.6
12	MAI	Main Building	332447.0	53798.0	29019.1	10158.5	14620.4
13	POB	Peter O'donnell Jr. Building	181805.0	51308.4	27736.7	23571.7	
14	JON	Jesse H. Jones Hall	216050.0	49208.1	25385.0	15432.2	8390.9
15	MBB	Moffett Molecular Biology Bldg.	177216.0	48366.3	25702.4	16028.9	6635.0
16	ERC	Frank C Erwin Special Events Center	490153.0	47657.6	24399.9	14512.4	8745.3
17	BEL	L. Theo Bellmont Hall	396712.0	46580.2	30470.6	16109.6	
18	TSC	Lee & Joe Jamail Texas Swimming Ctr	122122.0	44490.8	27458.2	11283.3	5749.3
19	KIN	Kinsolving Dormitory	243775.0	43990.9	25788.5	10027.5	8174.8
20	PAT	J.t. Patterson Labs.bldg.	155882.0	43309.5	22000.2	11683.2	9626.1
21	NEZ	North End Zone Building	563782.0	42052.6	22233.0	12825.3	6994.3
22	ECJ	Ernest Cockrell Jr. Hall	247723.0	41708.9	22703.4	10215.5	8790.0
23	SZB	George I. Sanchez Building	258353.0	41569.9	23736.6	5844.2	11989.2
24	PAC	Performing Arts Center	234662.0	40455.8	23252.5	7737.3	9466.0
25	UNB	Union Building	167238.0	39298.9	22361.1	10459.9	6477.9
26	JGB	Jackson Geological Sciences Bldg.	199628.0	38654.0	23385.2	10079.8	5189.0
27	SRH	Sid Richardson Hall	283345.0	35210.8	29505.2	4181.1	1524.5
28	FAC	Peter T. Flawn Academic Center	205141.0	35010.5	19278.4	6835.6	8896.5
29	HRC	Harry Ransom Center	251947.0	33953.6	17766.1	6638.0	9549.5
30	SJH	San Jacinto Residence Hall	301307.0	33619.8	19853.4	7618.2	6148.2
31	ARC	Animal Resources Center	95826.0	32242.7	21152.9	8187.0	2902.7
32	NST	Larry R. Faulkner Nano Sci And Tech	69394.0	31852.1	10267.5	8777.6	12807.0
33	BMC	Belo Center For New Media	126077.0	31525.8	27337.5	3401.4	786.9
34	PAI	T.s. Painter Hall	128536.0	31097.4	17030.5	6462.2	7604.7

35	ATT	At&t Executive Educ & Conf Center	352735.0	29600.0		29600.0	
36	GSB	Graduate School Of Business Bldg.	147205.0	28768.1	13640.9	4134.4	10992.8
37	BIO	Biological Laboratories	69799.0	28123.5	17534.7	6146.5	4442.4
38	CBA	College Of Business Administration	253863.0	26430.6	18931.9		7498.7
39	MRH	Music Building & Recital Hall	218016.0	25633.8	10722.9	5593.0	9317.9
40	SEA	Sarah M. & Charles E. Seay Building	193723.0	24477.8	14286.3	6461.0	3730.5
41	SAC	Student Activity Center	153999.0	23984.9	11978.7	7451.0	4555.2
42	SSB	Student Services Building	194881.0	23916.8	11516.1	10671.7	1729.0
43	TNH	Townes Hall	167164.0	23340.4	16904.6	621.1	5814.7
44	ADH	Almetris Duren Residence Hall	177708.0	22383.5	13383.5	5056.6	3943.5
45	ART	Art Building And Museum	157723.0	22011.8	12794.2	4792.9	4424.7
46	LBJ	Lyndon B Johnson Library	170607.0	21758.0	16541.6		5216.5
47	CMA	Jesse H. Jones Comm. Ctr. (Bldg. A)	111795.0	21709.0	10890.1	6206.2	4612.8
48	CMB	Jesse H. Jones Comm. Ctr. (Bldg. B)	107730.0	21167.2	3626.2	6708.4	10832.6
49	NHB	Norman Hackerman Building	305224.0	20403.2		20403.2	
50	WIN	F.l. Winship Drama Bldg.	107522.0	19768.2	11174.8	3374.3	5219.2
51	NUR	Nursing School	118152.0	19146.5	10976.1	2494.4	5676.0
52	EAS	Edgar A. Smith Building	60096.0	18357.2	15584.8	2772.3	0.1
53	RSC	Recreational Sports Center	119262.0	18279.6	9919.3	4831.1	3529.2
54	UTC	University Teaching Center	169053.0	18096.2	10564.7	4145.9	3385.5
55	BUR	Burdine Hall	101555.0	18017.2	8309.2	2511.9	3196.1
56	BHD	Brackenridge Hall Dorm	40697.0	16825.2	14815.9	848.6	1160.7
57	TMM	Texas Memorial Museum	35018.0	16421.6	1956.6	13872.7	592.3
58	DFA	E. William Doty Fine Arts Building	91254.0	14653.6	7622.5	3968.3	3062.8
59	WWH	Walter Webb Hall	38173.0	14458.8	3626.2		10832.6
60	MNC	Moncrief-Neuhaus Athletic Center	102422.0	14242.1	9990.5		4251.6
61	MHD	Moore-Hill Dormitory	97370.0	14078.8	8719.8	2829.7	2529.3
62	LTD	Littlefield Dormitory	57334.0	13085.5	7395.2	1905.2	3785.0
63	GOL	Goldsmith Hall	85623.0	12199.5	7068.3	2197.0	2934.2
64	SSW	School Of Social Work Building	93460.0	11882.4	6799.7	2574.4	2508.4
65	PAR	Parlin Hall	56137.0	9151.1	4618.7	2706.0	1826.4
66	UTX	Etter-Harbin Alumni Center	82939.0	8687.8	5392.2	3295.7	
67	UTA	Ut Administration Building	259032.0	8208.8		8208.8	
68	DCP	Denton A. Cooley Pavilion	44564.0	8008.9	4666.5	2225.4	1117.0
69	NOA	North Office Building A	86167.0	7747.0	4980.7	1010.7	1755.6
70	PPB	Printing And Press Bldg.	83708.0	7704.3		7704.3	
71	GAR	Garrison Hall	51778.0	7681.5	4262.7	1420.5	1998.2
72	BLD	Blanton Dormitory	69754.0	7467.0	4246.2	1726.9	1493.8
73	CAL	Calhoun Hall	55085.0	6912.1	4139.7	1480.6	1291.9

74	WMB	West Mall Office Bldg.	46230.0	6714.2	2784.9	2367.9	1561.3
75	LDH	Longhorn Dining Facility	8525.0	6129.5	2986.2	1165.7	1977.6
76	CRD	Carothers Dormitory	39648.0	6124.1	2710.5	1755.6	1658.1
77	GRG	Geography Building	31737.0	5974.5	3277.1	1261.3	1436.2
78	RHD	Roberts Hall Dormitory	45086.0	5911.9	3795.7	981.8	1134.4
79	CDL	Collections Deposit Library	64749.0	5756.0	3187.3	1443.4	1125.2
80	HRH	Rainey Hall	54405.0	5183.2	3301.2	37.6	1844.4
81	HSM	William Randolph Hearst Bldg	26033.0	4997.1	2859.8	1033.7	1103.6
82	HMA	Hogg Memorial Auditorium	24992.0	4865.3	3973.6	891.6	
83	BRG	Brazos Garage	481961.0	4295.6		4295.6	
84	PHD	Prather Hall Dormitory	44580.0	4260.0	2749.6	899.8	610.6
85	COM	Computation Center	14561.0	4257.3		4257.3	
86	EPS	E.p. Schoch Building	52559.0	4149.7	2397.4	1396.6	355.7
87	AND	Andrews Dormitory	41241.0	4082.4	3089.6	992.8	
88	GEA	Mary E. Gearing Hall	60621.0	3955.9	3362.6	281.8	311.5
89	BTL	Battle Hall	47191.0	3776.5	3685.5		91.0
90	BRB	Bernard And Audre Rapoport Building	50846.0	3713.8	2633.4	1080.4	
91	TRG	Trinity Garage	373416.0	3550.7		3550.7	
92	MFH	Richard Mithoff Trk/scr Fieldhouse	20372.0	3527.2	2086.6	452.6	988.0
93	LFH	Littlefield Home	16135.0	2984.8	2373.1	611.7	
94	SUT	Sutton Hall	59498.0	2811.7	1897.1	858.8	55.8
95	WAG	Waggener Hall	57762.0	2794.1		2694.1	99.9
96	MEZ	Mezes Hall	91629.0	2485.0		2485.0	
97	BEN	Benedict Hall	38598.0	2391.4		2391.4	
98	SWG	Speedway Garage	255507.0	2363.7		2363.7	
99	UIL	Univ. Interscholastic League Bldg.	34072.0	1811.8		1811.8	
100	TSG	27Th Street Garage	214252.0	1589.7		1589.7	
101	TCC	Joe C Thompson Conference Center	52357.0	1483.4		1483.4	
102	MMS	Mike A.myers Track & Soccer Stadium	16052.0	1439.2		1439.2	
103	BAT	Batts Hall	39143.0	1191.7		1191.7	
104	AHG	Anna Hiss Gymnasium	55240.0	981.5		981.5	
105	WCH	Will C. Hogg Bldg.	51483.0	824.3		824.3	
106	UPB	University Police Building	24463.0	756.1		756.1	
107	JHH	John W. Hargis Hall	22197.0	648.2		648.2	
108	CSB	Clark Field Support Building	1593.0	544.2		544.2	
109	CLA	Liberal Arts Building	226559.0	390.2		390.2	
110	ANB	Arno Nowotny Building	9850.0	177.6		177.6	
111	SHD	Simkins Hall Dormitory	39649.0	5540.1	3957.1		1583.0

Source: Utilities and Energy Management Indusoft Dashboard

Building Energy Consumption 1/1/2013 - 1/1/2014							
No.	Abbr	Building	SQFT	Total	Cooling	Electrical	Heating
1	WEL	Robert A. Welch Hall	428647.0	201938.1	111650.9	45826.6	44460.6
2	JCD	Jester Dormitory	745671.0	120710.4	62791.3	26381.9	31537.2
3	BMA	Jack S. Blanton Museum Of Art	137522.0	83065.8	33839.9	8650.6	40575.3
4	NMS	Neural And Molecular Science Bldg.	198458.0	76984.8	36059.8	28657.6	12267.4
5	CPE	Chemical And Petroleum Engineering	225939.0	74949.3	39807.9	15227.4	19914.0
6	BME	Biomedical Engineering Building	202942.0	64967.4	34412.8	13748.1	16806.6
7	PCL	Perry-Castaneda Library	492898.0	63300.4	35940.1	14528.4	12832.0
8	GRE	Gregory Gymnasium	262162.0	58964.7	33324.8	13094.7	12545.2
9	JES	Beauford H. Jester Center	178997.0	57449.0	34123.1	14512.1	8813.8
10	NEZ	North End Zone Building	563782.0	51169.3	25137.9	14967.0	11064.4
11	KIN	Kinsolving Dormitory	243775.0	50777.5	29314.1	10054.4	11409.0
12	RLM	Robert Lee Moore Hall	393530.0	50078.1	36940.6		13137.5
13	MAI	Main Building	332447.0	49918.5	25434.4	8866.5	15617.6
14	ERC	Frank C Erwin Special Events Center	490153.0	48275.5	22728.7	15058.9	10488.0
15	MBB	Moffett Molecular Biology Bldg.	177216.0	47409.8	24135.2	16697.5	6577.1
16	BMC	Belo Center For New Media	126077.0	47108.3	40118.5	3329.3	3660.4
17	PAT	J.t. Patterson Labs.bldg.	155882.0	46576.2	23905.6	10897.6	11773.0
18	ETC	Engineering Teaching Center Ii	229973.0	45673.5	26804.1	12508.4	6361.0
19	BEL	L. Theo Bellmont Hall	396712.0	43891.7	28325.7	15566.1	
20	UNB	Union Building	167238.0	40947.6	21588.3	10228.5	9130.8
21	POB	Peter O'donnell Jr. Building	181805.0	36296.2	18992.7	17303.6	
22	ARC	Animal Resources Center	95826.0	35735.5	20142.0	8041.4	7552.0
23	SZB	George I. Sanchez Building	258353.0	34733.0	18517.4	6025.0	10190.6
24	PAC	Performing Arts Center	234662.0	34488.3	18754.5	7674.3	8059.5
25	BIO	Biological Laboratories	69799.0	34126.8	18012.3	6092.3	10022.2
26	SJH	San Jacinto Residence Hall	301307.0	33628.1	19082.1	7458.4	7087.6
27	ECJ	Ernest Cockrell Jr. Hall	247723.0	33498.2	17269.3	8730.2	7498.7
28	JON	Jesse H. Jones Hall	216050.0	33410.9	15943.9	13505.2	3961.9
29	TSC	Lee & Joe Jamail Texas Swimming Ctr	122122.0	32823.2	16486.3	10700.9	5636.0
30	JGB	Jackson Geological Sciences Bldg.	199628.0	32332.8	16999.1	10067.8	5265.9
31	HRC	Harry Ransom Center	251947.0	30772.7	15396.5	6671.6	8704.6
32	FAC	Peter T. Flawn Academic Center	205141.0	30351.1	16155.3	6784.2	7411.6
33	ATT	At&t Executive Educ & Conf Center	352735.0	29895.8		29895.8	
34	SRH	Sid Richardson Hall	283345.0	28278.3	20247.5	5391.8	2639.0
35	PAI	T.s. Painter Hall	128536.0	28215.7	14525.1	6062.2	7628.4
36	MRH	Music Building & Recital Hall	218016.0	26949.4	10452.9	5567.5	10929.0

37	SAC	Student Activity Center	153999.0	25859.6	15921.8	6365.4	3572.5
38	ART	Art Building And Museum	157723.0	25368.5	15838.3	4448.6	5081.7
39	NST	Larry R. Faulkner Nano Sci And Tech	69394.0	24840.9	8727.8	8707.3	7405.9
40	EAS	Edgar A. Smith Building	60096.0	23616.2	14538.4	2841.2	6236.7
41	CBA	College Of Business Administration	253863.0	21302.3	16162.0		5140.2
42	TNH	Townes Hall	167164.0	21194.5	13391.0	719.0	7084.6
43	WIN	F.l. Winship Drama Bldg.	107522.0	21039.5	11384.9	3486.9	6167.8
44	CMB	Jesse H. Jones Comm. Ctr. (Bldg. B)	107730.0	20975.6	2971.1	6678.5	11325.9
45	NHB	Norman Hackerman Building	305224.0	20398.8		20398.8	
46	RSC	Recreational Sports Center	119262.0	20168.7	11082.1	4669.0	4417.6
47	ADH	Almetris Duren Residence Hall	177708.0	19507.8	10515.4	4730.2	4262.2
48	SSB	Student Services Building	194881.0	19205.9	9480.9	7100.8	2624.1
49	BUR	Burdine Hall	101555.0	18988.5	8053.8	2416.7	3870.7
50	SEA	Sarah M. & Charles E. Seay Building	193723.0	18051.5	9837.8	5879.3	2334.5
51	GDC	Gates Dell Complex	237702.0	17784.2	17784.2		
52	NUR	Nursing School	118152.0	17394.2	8524.3	3594.8	5275.1
53	GSB	Graduate School Of Business Bldg.	147205.0	17104.0	10580.8	4038.7	2484.6
54	UTC	University Teaching Center	169053.0	16041.9	9787.5	3949.9	2304.5
55	WWH	Walter Webb Hall	38173.0	14297.0	2971.1		11325.9
56	CMA	Jesse H. Jones Comm. Ctr. (Bldg. A)	111795.0	14283.3	8897.0	4618.9	767.4
57	MNC	Moncrief-Neuhaus Athletic Center	102422.0	14212.0	9291.4		4920.6
58	LBJ	Lyndon B Johnson Library	170607.0	13925.3	12018.8		1906.5
59	MHD	Moore-Hill Dormitory	97370.0	13539.1	8154.5	2687.4	2697.2
60	DFA	E. William Doty Fine Arts Building	91254.0	12939.1	5343.0	3473.4	4122.7
61	LTD	Littlefield Dormitory	57334.0	12635.1	7025.9	1903.3	3705.9
62	GOL	Goldsmith Hall	85623.0	12487.9	7079.8	2117.6	3290.6
63	SSW	School Of Social Work Building	93460.0	11036.6	4902.5	2419.7	3714.4
64	UTA	Ut Administration Building	259032.0	11016.4		11016.4	
65	BHD	Brackenridge Hall Dorm	40697.0	10087.7	7770.1	846.8	1470.8
66	DCP	Denton A. Cooley Pavilion	44564.0	8878.9	5116.7	2429.2	1333.1
67	PPB	Printing And Press Bldg.	83708.0	8027.5		8027.5	
68	UTX	Etter-Harbin Alumni Center	82939.0	7558.4	4417.3	3141.1	
69	PAR	Parlin Hall	56137.0	7280.5	4053.6	1595.8	1631.0
70	LDH	Longhorn Dining Facility	8525.0	6900.0	3335.9	1109.1	2455.0
71	WMB	West Mall Office Bldg.	46230.0	6847.3	2876.3	2124.8	1846.2
72	BLD	Blanton Dormitory	69754.0	6831.3	3448.3	1655.8	1727.2
73	CDL	Collections Deposit Library	64749.0	6673.7	3550.0	1454.3	1669.4
74	NOA	North Office Building A	86167.0	6640.7	3527.1	1736.3	1377.4
75	GEA	Mary E. Gearing Hall	60621.0	6456.2	3928.5	1817.0	710.7

76	RHD	Roberts Hall Dormitory	45086.0	6446.3	4332.7	996.6	1116.9
77	AND	Andrews Dormitory	41241.0	5927.8	3626.3	983.9	1317.6
78	CRD	Carothers Dormitory	39648.0	5889.5	2570.0	1626.9	1692.6
79	CAL	Calhoun Hall	55085.0	5766.9	3607.0	1069.7	1090.2
80	GAR	Garrison Hall	51778.0	5740.9	3040.7	1240.3	1459.9
81	SUT	Sutton Hall	59498.0	5646.7	4015.0	1450.9	180.8
82	CLA	Liberal Arts Building	226559.0	5631.0		5631.0	
83	PHD	Prather Hall Dormitory	44580.0	5409.2	3539.7	980.5	889.0
84	HRH	Rainey Hall	54405.0	4519.5	2418.1	730.7	1370.7
85	WCH	Will C. Hogg Bldg.	51483.0	4412.3	3268.6	1143.7	
86	COM	Computation Center	14561.0	4261.9		4261.9	
87	HMA	Hogg Memorial Auditorium	24992.0	4151.2	3331.0	820.3	
88	BRG	Brazos Garage	481961.0	4133.1		4133.1	
89	EPS	E.p. Schoch Building	52559.0	3899.7	2326.5	1215.2	358.1
90	MFH	Richard Mithoff Trk/scr Fieldhouse	20372.0	3708.9	2116.9	455.2	1136.8
91	BRB	Bernard And Audre Rapoport Building	50846.0	3643.1	2563.4	1079.8	
92	HSM	William Randolph Hearst Bldg	26033.0	3601.7	1735.4	913.2	953.1
93	TRG	Trinity Garage	373416.0	3453.6		3453.6	
94	TMM	Texas Memorial Museum	35018.0	3247.1	1744.0	824.8	678.2
95	WAG	Waggener Hall	57762.0	3208.1		2350.0	858.1
96	MEZ	Mezes Hall	91629.0	2608.5		2608.5	
97	BTL	Battle Hall	47191.0	2511.3	2444.3		67.0
98	TCC	Joe C Thompson Conference Center	52357.0	2322.2		1573.0	749.2
99	SWG	Speedway Garage	255507.0	2228.8		2228.8	
100	BEN	Benedict Hall	38598.0	2133.4		2133.4	
101	UIL	Univ. Interscholastic League Bldg.	34072.0	1631.1		1631.1	
102	MMS	Mike A.myers Track & Soccer Stadium	16052.0	1268.1		1268.1	
103	TSG	27Th Street Garage	214252.0	1136.4		1136.4	
104	BAT	Batts Hall	39143.0	1103.8		1103.8	
105	UPB	University Police Building	24463.0	968.2		968.2	
106	AHG	Anna Hiss Gymnasium	55240.0	930.9		930.9	
107	CSB	Clark Field Support Building	1593.0	638.6		638.6	
108	JHH	John W. Hargis Hall	22197.0	602.7		602.7	
109	LFH	Littlefield Home	16135.0	521.9		521.9	
110	ANB	Arno Nowotny Building	9850.0	196.2		196.2	
111	SHD	Simkins Hall Dormitory	39649.0	5499.7	3666.6		1833.0

Source: Utilities and Energy Management Indusoft Dashboard

Appendix C: UT Building Water Consumption, 1/1/2011 – 1/1/2014

This Appendix lists the domestic water consumption data for buildings metered between 2011 and 2013. Those buildings that contained errors in the raw data are already corrected here. Water consumption is measured in K- gallons. The three tables below represents the years 2011, 2012, and 2013. Blank spaces represent data not metered. The date of retrieval is Feb. 3, 2015.

Building Water Consumption 1/1/2011 - 1/1/2012

No.	Abbr	Building	SQFT	Water
1	JCD	Jester Dormitory	745671	36212000
2	GRG	Geography Building	31737	13253941
3	WEL	Robert A. Welch Hall	428647	11691200
4	HRH	Rainey Hall	54405	10359295
5	SJH	San Jacinto Residence Hall	301307	7381000
6	JES	Beauford H. Jester Center	178997	5937000
7	ETC	Engineering Teaching Center Ii	229973	5719800
8	GRE	Gregory Gymnasium	262162	4362100
9	ERC	Frank C Erwin Special Events Center	490153	3906900
10	UNB	Union Building	167238	3594150
11	TSC	Lee & Joe Jamail Texas Swimming Ctr	122122	3573300
12	MHD	Moore-Hill Dormitory	97370	3470300
13	PCL	Perry-Castaneda Library	492898	3230000
14	BLD	Blanton Dormitory	69754	3048900
15	ARC	Animal Resources Center	95826	2882700
16	BME	Biomedical Engineering Building	202942	2765600
17	MNC	Moncrief-Neuhaus Athletic Center	102422	2250000
18	PAT	J.t. Patterson Labs.bldg.	155882	2192800
19	NMS	Neural And Molecular Science Bldg.	198458	1808000
20	SAC	Student Activity Center	153999	1794746
21	MBB	Moffett Molecular Biology Bldg.	177216	1710000
22	PHD	Prather Hall Dormitory	44580	1655686
23	BHD	Brackenridge Hall Dorm	40697	1607720
24	RHD	Roberts Hall Dormitory	45086	1546600
25	FAC	Peter T. Flawn Academic Center	205141	1539200
26	ART	Art Building And Museum	157723	1353900
27	GSB	Graduate School Of Business Bldg.	147205	1315580
28	SRH	Sid Richardson Hall	283345	1305900
29	TNH	Townes Hall	167164	1236351
30	MAI	Main Building	332447	1206810
31	CBA	College Of Business Administration	253863	1135455

32	SZB	George I. Sanchez Building	258353	1096700
33	TCC	Joe C Thompson Conference Center	52357	1045000
34	SSW	School Of Social Work Building	93460	1039060
35	SSB	Student Services Building	194881	976770
36	AHG	Anna Hiss Gymnasium	55240	914700
37	EAS	Edgar A. Smith Building	60096	802800
38	ECJ	Ernest Cockrell Jr. Hall	247723	750230
39	NOA	North Office Building A	86167	736320
40	RSC	Recreational Sports Center	119262	723000
41	JGB	Jackson Geological Sciences Bldg.	199628	692500
42	HRC	Harry Ransom Center	251947	691760
43	UTX	Etter-Harbin Alumni Center	82939	670500
44	MFH	Richard Mithoff Trk/scr Fieldhouse	20372	616860
45	MRH	Music Building & Recital Hall	218016	610576
46	UTC	University Teaching Center	169053	598000
47	PAC	Performing Arts Center	234662	552000
48	JON	Jesse H. Jones Hall	216050	550000
49	LDH	Longhorn Dining Facility	8525	546100
50	MEZ	Mezes Hall	91629	532600
51	SEA	Sarah M. & Charles E. Seay Building	193723	518670
52	LBJ	Lyndon B Johnson Library	170607	474100
53	NUR	Nursing School	118152	417000
54	GOL	Goldsmith Hall	85623	393500
55	BUR	Burdine Hall	101555	386800
56	DCP	Denton A. Cooley Pavilion	44564	349200
57	CRD	Carothers Dormitory	39648	344300
58	BEN	Benedict Hall	38598	330200
59	DFA	E. William Doty Fine Arts Building	91254	244000
60	GAR	Garrison Hall	51778	181300
61	BMA	Jack S. Blanton Museum Of Art	137522	157800
62	CPE	Chemical And Petroleum Engineering	225939	154600
63	EPS	E.p. Schoch Building	52559	132300
64	BAT	Batts Hall	39143	126000
65	NST	Larry R. Faulkner Nano Sci And Tech	69394	121100
66	HSM	William Randolph Hearst Bldg	26033	91772.1
67	POB	Peter O'donnell Jr. Building	181805	40941
68	CMA	Jesse H. Jones Comm. Ctr. (Bldg. A)	111795	34919
69	TMM	Texas Memorial Museum	35018	23646
70	PAR	Parlin Hall	56137	21740
71	WMB	West Mall Office Bldg.	46230	19976
72	BRG	Brazos Garage	481961	5200
73	TSG	27Th Street Garage	214252	2110
74	CDL	Collections Deposit Library	64749	400

Source: Utilities and Energy Management Indusoft Dashboard

Building Water Consumption 1/1/2012 - 1/1/2013				
No.	Abbr	Building	SQFT	Water
1	JCD	Jester Dormitory	745671	36056000
2	WEL	Robert A. Welch Hall	428647	10195600
3	JES	Beauford H. Jester Center	178997	8993670
4	SJH	San Jacinto Residence Hall	301307	7717000
5	CPE	Chemical And Petroleum Engineering	225939	5412480
6	ETC	Engineering Teaching Center Ii	229973	4867700
7	GRE	Gregory Gymnasium	262162	4433900
8	SAC	Student Activity Center	153999	3918866
9	TSC	Lee & Joe Jamail Texas Swimming Ctr	122122	3810800
10	MHD	Moore-Hill Dormitory	97370	3660300
11	ERC	Frank C Erwin Special Events Center	490153	3585700
12	PCL	Perry-Castaneda Library	492898	3350000
13	UNB	Union Building	167238	3028000
14	ARC	Animal Resources Center	95826	2559800
15	BME	Biomedical Engineering Building	202942	2440300
16	ECJ	Ernest Cockrell Jr. Hall	247723	2340970
17	MNC	Moncrief-Neuhaus Athletic Center	102422	2122000
18	NMS	Neural And Molecular Science Bldg.	198458	2062000
19	CMA	Jesse H. Jones Comm. Ctr. (Bldg. A)	111795	1967290
20	PHD	Prather Hall Dormitory	44580	1901327
21	MBB	Moffett Molecular Biology Bldg.	177216	1838000
22	BLD	Blanton Dormitory	69754	1767500
23	PAT	J.t. Patterson Labs.bldg.	155882	1677100
24	MAI	Main Building	332447	1600635
25	SSB	Student Services Building	194881	1464620
26	GSB	Graduate School Of Business Bldg.	147205	1444650
27	RHD	Roberts Hall Dormitory	45086	1424300
28	FAC	Peter T. Flawn Academic Center	205141	1403200
29	BHD	Brackenridge Hall Dorm	40697	1353060
30	SZB	George I. Sanchez Building	258353	1325900
31	POB	Peter O'donnell Jr. Building	181805	1139940
32	CBA	College Of Business Administration	253863	1132979
33	TNH	Townes Hall	167164	1081353
34	ART	Art Building And Museum	157723	1032900
35	EAS	Edgar A. Smith Building	60096	1021200
36	JGB	Jackson Geological Sciences Bldg.	199628	993900
37	SRH	Sid Richardson Hall	283345	928900
38	SSW	School Of Social Work Building	93460	872080
39	CRD	Carothers Dormitory	39648	865500
40	HRH	Rainey Hall	54405	847744
41	RSC	Recreational Sports Center	119262	846000
42	UTC	University Teaching Center	169053	774700
43	PAC	Performing Arts Center	234662	769000
44	NOA	North Office Building A	86167	682930

45	MRH	Music Building & Recital Hall	218016	651805
46	MFH	Richard Mithoff Trk/scr Fieldhouse	20372	579300
47	UTX	Etter-Harbin Alumni Center	82939	568800
48	SEA	Sarah M. & Charles E. Seay Building	193723	535200
49	TCC	Joe C Thompson Conference Center	52357	483200
50	JON	Jesse H. Jones Hall	216050	469000
51	LDH	Longhorn Dining Facility	8525	420900
52	LBJ	Lyndon B Johnson Library	170607	389600
53	MEZ	Mezes Hall	91629	384200
54	BUR	Burdine Hall	101555	378500
55	HRC	Harry Ransom Center	251947	376640
56	DCP	Denton A. Cooley Pavilion	44564	373600
57	NUR	Nursing School	118152	365000
58	DFA	E. William Doty Fine Arts Building	91254	343430
59	GOL	Goldsmith Hall	85623	310900
60	BEN	Benedict Hall	38598	269200
61	GAR	Garrison Hall	51778	225500
62	AHG	Anna Hiss Gymnasium	55240	180200
63	EPS	E.p. Schoch Building	52559	167300
64	GRG	Geography Building	31737	164406
65	CLA	Liberal Arts Building	226559	157200
66	BMA	Jack S. Blanton Museum Of Art	137522	139500
67	WMB	West Mall Office Bldg.	46230	119030
68	BAT	Batts Hall	39143	119000
69	NST	Larry R. Faulkner Nano Sci And Tech	69394	106400
70	TMM	Texas Memorial Museum	35018	76208
71	HSM	William Randolph Hearst Bldg	26033	69040.4
72	BRG	Brazos Garage	481961	19300
73	CDL	Collections Deposit Library	64749	18400
74	PAR	Parlin Hall	56137	17910
75	TSG	27Th Street Garage	214252	2290

Source: Utilities and Energy Management Indusoft Dashboard

Building Water Consumption 1/1/2013 - 1/1/2014				
No.	Abbr	Building	SQFT	Water
1	JCD	Jester Dormitory	745671	33828000
2	JES	Beauford H. Jester Center	178997	7985220
3	SJH	San Jacinto Residence Hall	301307	7407000
4	SAC	Student Activity Center	153999	7223984
5	WEL	Robert A. Welch Hall	428647	6950900
6	PCL	Perry-Castaneda Library	492898	6166700
7	MHD	Moore-Hill Dormitory	97370	4317900
8	TSC	Lee & Joe Jamail Texas Swimming Ctr	122122	4099500
9	GRE	Gregory Gymnasium	262162	3958100
10	ETC	Engineering Teaching Center Ii	229973	3868100
11	CPE	Chemical And Petroleum Engineering	225939	3847380
12	BME	Biomedical Engineering Building	202942	3693100
13	ERC	Frank C Erwin Special Events Center	490153	3664300
14	UNB	Union Building	167238	3040820
15	ARC	Animal Resources Center	95826	2847640
16	CLA	Liberal Arts Building	226559	2768400
17	NMS	Neural And Molecular Science Bldg.	198458	2323000
18	MNC	Moncrief-Neuhaus Athletic Center	102422	2207000
19	ECJ	Ernest Cockrell Jr. Hall	247723	2043750
20	BLD	Blanton Dormitory	69754	2019000
21	MAI	Main Building	332447	2009672
22	PHD	Prather Hall Dormitory	44580	1971572
23	MBB	Moffett Molecular Biology Bldg.	177216	1910000
24	SSB	Student Services Building	194881	1762420
25	RHD	Roberts Hall Dormitory	45086	1654707
26	PAT	J.t. Patterson Labs.bldg.	155882	1567900
27	GSB	Graduate School Of Business Bldg.	147205	1405230
28	BHD	Brackenridge Hall Dorm	40697	1369600
29	CMA	Jesse H. Jones Comm. Ctr. (Bldg. A)	111795	1366420
30	UTX	Etter-Harbin Alumni Center	82939	1312800
31	JGB	Jackson Geological Sciences Bldg.	199628	1240300
32	SRH	Sid Richardson Hall	283345	1195000
33	CBA	College Of Business Administration	253863	1160231
34	CRD	Carothers Dormitory	39648	1136200
35	TNH	Townes Hall	167164	1093083
36	ART	Art Building And Museum	157723	1012500
37	PAC	Performing Arts Center	234662	910000
38	POB	Peter O'donnell Jr. Building	181805	856650
39	RSC	Recreational Sports Center	119262	833000
40	SSW	School Of Social Work Building	93460	813280
41	LDH	Longhorn Dining Facility	8525	796600
42	HRH	Rainey Hall	54405	786374
43	UTC	University Teaching Center	169053	758600
44	SZB	George I. Sanchez Building	258353	701120

45	NOA	North Office Building A	86167	624100
46	MFH	Richard Mithoff Trk/scr Fieldhouse	20372	624030
47	MRH	Music Building & Recital Hall	218016	617081
48	MEZ	Mezes Hall	91629	563300
49	BUR	Burdine Hall	101555	522200
50	SEA	Sarah M. & Charles E. Seay Building	193723	469520
51	JON	Jesse H. Jones Hall	216050	458000
52	FAC	Peter T. Flawn Academic Center	205141	452600
53	LBJ	Lyndon B Johnson Library	170607	443400
54	HRC	Harry Ransom Center	251947	441600
55	EAS	Edgar A. Smith Building	60096	439900
56	TCC	Joe C Thompson Conference Center	52357	389700
57	NUR	Nursing School	118152	361500
58	DCP	Denton A. Cooley Pavilion	44564	328000
59	DFA	E. William Doty Fine Arts Building	91254	271600
60	GAR	Garrison Hall	51778	237400
61	BEN	Benedict Hall	38598	225700
62	GOL	Goldsmith Hall	85623	207400
63	AHG	Anna Hiss Gymnasium	55240	196000
64	PAR	Parlin Hall	56137	186060
65	BMA	Jack S. Blanton Museum Of Art	137522	180300
66	NST	Larry R. Faulkner Nano Sci And Tech	69394	107300
67	BAT	Batts Hall	39143	90000
68	WMB	West Mall Office Bldg.	46230	89825
69	EPS	E.p. Schoch Building	52559	79300
70	TMM	Texas Memorial Museum	35018	74555
71	HSM	William Randolph Hearst Bldg	26033	66393.4
72	CDL	Collections Deposit Library	64749	21700
73	BRG	Brazos Garage	481961	21000
74	TSG	27Th Street Garage	214252	1690

Source: Utilities and Energy Management Indusoft Dashboard

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